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PROCESS ENERGY INVENTORY AT IOWA ARMY AMMUNITION PLANT LINES 1, 2, AND 3A

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This project was accomplished as part of the US Army's Manufacturing Methods and Technology Program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques, and equipment for use in production of Army materiel.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Energy conservation
Energy audit
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A process energy audit was conducted at Iowa Army Ammunition Plant. Lines 1, 2, and 3A were surveyed. Energy consumption baselines were established for eight production items: the Hawk, Stinger, Chaparral, Dragon, Copperhead and Improved TOW Warheads, the M549A1 RA Projectile, and the M718/M741 AT Projectile. A number of potential energy conservation projects were defined to reduce present energy use.

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INTRODUCTION

The objectives of this project were: (a) to conduct a comprehensive process energy audit of two (2) load lines at the Iowa Army Ammunition Plant and (b) to define potential process related energy saving measures and projects. Three load lines were actually monitored to include all major large caliber warheads and projectiles loaded at the IAAP. The load lines were IAAP Load Lines 1, 2 and 3A. During the course of this phase of the project, the production items audited were the M258 HE Warhead (STINGER), the M250 HE Warhead (CHAPARRAL), the M155 HE Warhead (HAWK), the M225 HE Warhead (DRAGON), the M712 HE Warhead (COPPERHEAD), the 155MM, M549 HE Rocket Assisted Projectile, the 155MM, M718/M741 HE Projectile (RAAMS) and the M207E1 HE Warhead (I-TOW).

This project determined that the L/A/P of the M155, HE, GM, Warhead (HAWK) will consume 1,430 MBTU per year at a production rate of 5,544 warheads per year as produced at the Iowa Army Ammunition Plant. This amounts to 257,937 BTU per warhead. Potential energy conservation projects described in this project would conserve approximately 904 MBTU per year. This would reduce the process energy consumption by 63.2% to 526 MBTU per year or 94,877 BTU per warhead.

The process energy consumed in the L/A/P of the M258, HE Warhead (STINGER) totaled 1,105 MBTU at a production rate of 5,040 warheads per year, as produced at the Iowa Army Ammunition Plant. This amounts to 219,246 BTU per warhead. Potential energy conservation projects described in this project would save approximately 772 MBTU per year. This would reduce the process energy consumption by 69.9% to 333 MBTU per year or 66,071 BTU per warhead.

The process energy consumed in the L/A/P of the M250, HE, GM Warhead (CHAPARRAL) totaled 1,578 MBTU per year at a production rate of 12,096 warheads per year, as produced at the Iowa Army Ammunition Plant. This amounts to 130,456 BTU per warhead. Potential energy conservation projects described in this project would conserve approximately 1,087 MBTU per year. This would reduce the process energy consumption by 68.9% to 491 MBTU per year or 40,592 BTU per warhead.

The process energy consumed by the M225, HE, GM, Warhead (DRAGON) totaled 1,041 MBTU per year at a standard production rate of 12,000 warheads per year, as produced at the Iowa Army Ammunition Plant. Planned mobilization production of 21,600 warheads per year would consume 1,365 MBTU per year. This amounts to 86,750 BTU per warhead at standard production and 63,194 BTU at mobilization rates. The energy saving measures described in this report would save 584 MBTU per year. This would reduce standard production consumption by 56.1% to 457 MBTU per year or 38,083 BTU per warhead. Mobilization energy consumption would be reduced by 42.8% to 781 MBTU per year or 36,157 BTU per warhead.

The process energy consumed by the M712, HE, GM Warhead (COPPERHEAD) totaled 1,012 MBTU at a standard production rate of 9,576 warheads per year. Planned mobilization production of 19,200 warheads per year would consume 1,385 MBTU per year. This amounts to 105,681 BTU per warhead at standard production and 72,135 BTU per warhead at mobilization. The energy saving measures described in this project would save 584 MBTU per year. This would reduce standard production consumption by 57.7% to 428 MBTU per year or 44,695 BTU per warhead. Mobilization energy consumption would be reduced by 42.2% to 801 MBTU per year or 41,719 BTU per warhead.

The process energy consumed by the M549A1, 155MM, HE, RA Projectile totaled 5,108 MBTU at a production rate of 99,036 projectiles per year, as produced at the Iowa Army Ammunition Plant. This amounts to 51,572 BTU per projectile. Planned mobilization production of 585,600 projectiles per year would consume 28,417 MBTU. The energy saving measures described in this project would save 646 MBTU per year. This would reduce standard production consumption by 12.65% to 4,466 MBTU per year or 45,095 BTU per projectile. Mobilization energy consumption would be reduced by 2.27% to 27,771 MBTU per year or 47,423 BTU per projectile.

The process energy consumed by the M207E1, HE Warhead (I-TOW) totaled 1,797 MBTU at a standard production rate of 38,808 warheads per year as produced at the Iowa Army Ammunition Plant. This amounts to 46,297 BTU per warhead. Planned mobilization production of 54,000 warheads per year would consume 2,500 MBTU per year. The energy saving measures described in this project would save 48 MBTU per year. This would reduce standard production consumption by 2.67% to 1,749 MBTU per year or 45,068 BTU per warhead. Mobilization energy consumption would be reduced by 1.92% to 2,452 MBTU per year or 45,407 BTU per warhead.

The process energy consumed by the M718/M741, 155MM, AT Projectile totaled 2,895 MBTU per year at a standard production rate of 36,792 projectiles per year, as produced at the Iowa Army Ammunition Plant. This amounts to 78,694 BTU per projectile. Planned mobilization production of 60,000 projectiles per year would consume 4,722 MBTU per year. The energy saving measures described in this report would save 192 MBTU per year. This would reduce standard production consumption by 6.63% to 2,703 MBTU per year or 73,467 BTU per projectile. Mobilization energy consumption would be reduced by 4.07% to 4,530 MBTU per year or 75,500 BTU per projectile.

In addition to direct process energy savings, an additional 4,578 MBTU per year could be saved by utilizing waste building heat for process applications.

Table 1, which follows, graphically depicts this potential energy savings.

TABLE 1
POTENTIAL PROCESS ENERGY SAVINGS

PROD. ITEM	PRESENT CONSUMPTION (MBTU/YR)	AUTOMATIC CONTROL (MBTU/YR)	INSULATION (MBTU/YR)	POTENTIAL CONSUMPTION (MBTU/YR)	PERCENT REDUCTION
HAWK	1430*	315	589*	526	63.22
STINGER	1105*	503	269	333	69.86
CHAPARRAL	1578*	818*	269	491	68.88
DRAGON (STD)	1041*	315	269	503	51.68
DRAGON (MOB)	1365	315	269	781	42.78
COPPERHEAD (STD)	1012*	315*	269*	428	57.71
COPPERHEAD (MOB)	1385	315	269	801	42.17
M549A1 (STD)	5107*	377*	269*	4461	12.65
M549A1 (MOB)	28417	377	269	27771	2.27
M207E1 (STD)	1797*	**	48*	1749	2.67
M207E1 (MOB)	2500	**	48	2452	1.92
M718/M741 (STD)	2895*	**	192*	2703	6.63
M718/M741 (MOB)	4722	**	192	4530	4.07
TOTALS	15965	1510	1367		

* INCLUDED IN TOTALS

** AUTOMATIC TIMERS PRESENTLY IN USE

RECLAIM HEAT FROM HIGH PRESSURE TRAPS IN MELT BUILDINGS ------ 4578 MBTU/YR*

GRAND TOTAL ------ 7455 MBTU/YR

DATA ACQUISITION METHODOLOGY

Steam:

Steam data was obtained using two different methods depending on certain situations.

1. Steam data was obtained by measuring condensate with a tared bucket, scale and stopwatch. Test lines were taken off condensate lines as soon after the trap as possible. Attempts were made to measure each individual unit independently, however, in a few cases, units were clustered to obtain the desired data.
2. A variable orifice steam flow meter was purchased and installed on the process steam line in Building 1-05-2. Building 1-05-2 is the primary melt building monitored in this project.

Electricity:

Electrical data was obtained using four different methods depending on certain situations.

1. A portable KW-HR meter was designed and built for utilization where possible. The meter was hooked in line with the particular machinery and monitored for a specific amount of time. The number of production items processed through this machine was monitored and unit energy consumption was determined using this data.
2. An industrial analyzer was purchased for utilization where possible. The meter was hooked in line with the machinery and monitored. The meter reads kilowatts, volts, amps and power factor. Using this data and engineering calculations, appropriate energy consumption figures were generated.
3. Where safety regulations prohibited the above methods, indirect methods were used. A clamp on ammeter was used at a building substation to determine average current draw. Energy consumption was calculated using these figures.

4. When none of the above methods was feasible, available utility consumption figures were used.

Air:

An investigation into the possibility of individual air flow meters determined this method to be too costly; therefore, available manufacturers' air consumption data was used to generate the appropriate energy consumption figures.

General:

Due to irregular production schedules, some data was calculated based on the first phase of this project. This method, although considered accurate, was used only when no other alternative was available.

Abbreviations and Conversion Factors Used in This Report:

KW-HR = Kilowatt-Hours

BTUH = BTU per Hour

PSIG = Pounds per Square Inch, Gauge

LF = Lineal Feet

MBTU = Mega - BTU

h_{fg} = Latent Heat of Vaporization

Electricity - 3,413 BTU/KW-HR

Air - 9.8 BTU/ft^3 - air

Yearly Production Rates

M258 (STINGER)	Standard	5040/yr
	Mobilization	N/A
M250 (CHAPARRAL)	Standard	12,096/yr
	Mobilization	N/A
M155 (HAWK)	Standard	5544/yr
	Mobilization	N/A
M712 (COPPERHEAD)	Standard	9576/yr
	Mobilization	19,200/yr
M718/M714 (RAAMS)	Standard	36,792/yr
	Mobilization	60,000/yr
M549 (155MM)	Standard	99,036/yr
	Mobilization	585,600/yr
M207E1 (I-TOW)	Standard	38,808/yr
	Mobilization	54,000/yr
M225 (DRAGON)	Standard	12,000/yr
	Mobilization	21,600/yr

M155, HE, GM, WARHEAD (HAWK)

PROCESS DESCRIPTION

The M155 (HAWK) is a missile warhead filled with approximately 80 pounds of explosive. A standard production rate of 5,544 warheads per year has been used in this report. The M155 is not included in the latest IAAP mobilization schedule.

Explosive materials are received at service magazines, screened, weighed and transferred to the melt building. The warheads with S&A devices are received and transferred to the melt building for loading.

The explosive materials are melted and maintained at a temperature of 205°F ± 5°F. The melted explosive is then poured into the warheads. The loaded warheads are transferred to a conditioning bay where they are maintained in a bath water system at 130°F ± 5°F for a minimum of nine hours. After conditioning, they are allowed to cool for a minimum of eight hours. The booster pellets are then installed and the warhead is transferred to the x-ray building. The accepted warheads are transferred to the assembly building.

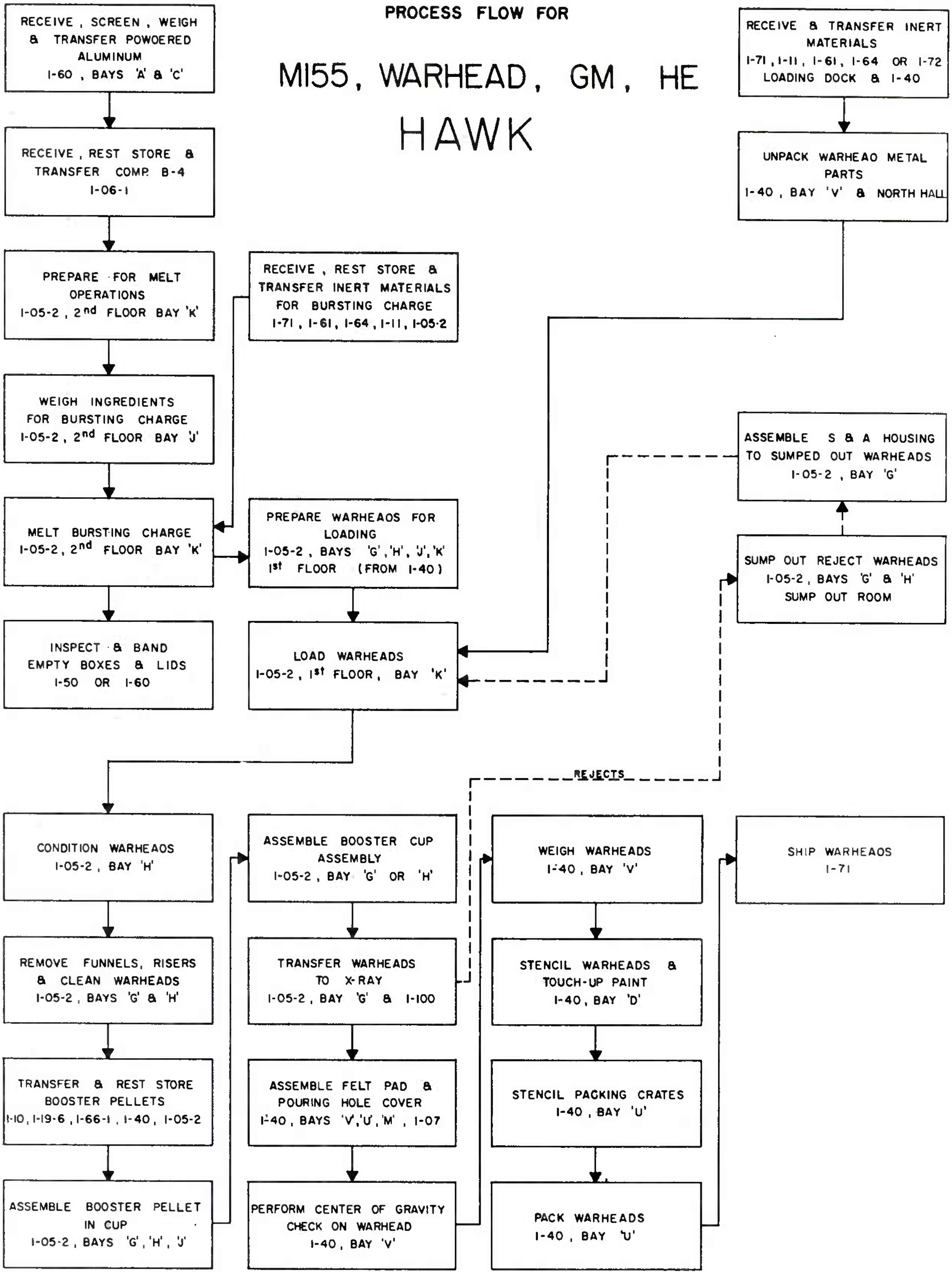
In the assembly building, the felt pad and pouring hole cover is installed, a center of gravity test is performed, and the warheads are weighed. The warheads are stenciled and packed into wooden crates. The warheads are then transferred for storage or shipping out of the plant.

The above description of the manufacturing process was extracted from the following Iowa Army Ammunition Plant Standing Operating Procedure:

S.O.P. No. 718, Rev. 1 - Load, Assemble and Pack Warhead Section, Guided Missile, HE, M155

PROCESS FLOW FOR

M155, WARHEAD, GM, HE
HAWK



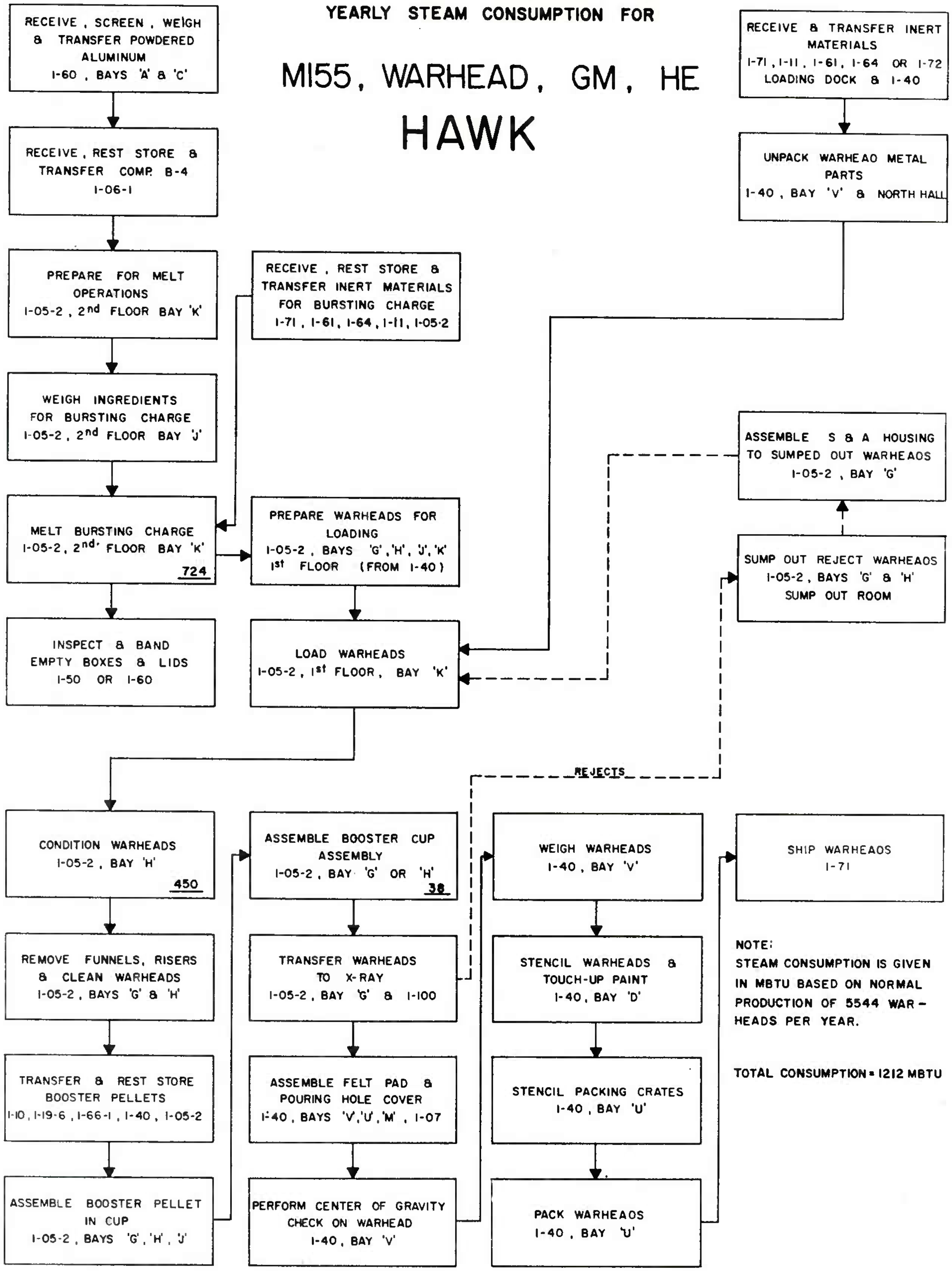
Energy Consumption

The process energy consumed in the L/A/P of M155, HE, GM Warhead (HAWK) totaled 1430 MBTU per year at a production rate of 5,544 warheads per year, as produced at the Iowa Army Ammunition Plant. This amounts to 257,937 BTU per warhead.

The following charts show a breakdown of energy consumption by production step and form of energy.

YEARLY STEAM CONSUMPTION FOR

M155, WARHEAD, GM, HE
HAWK

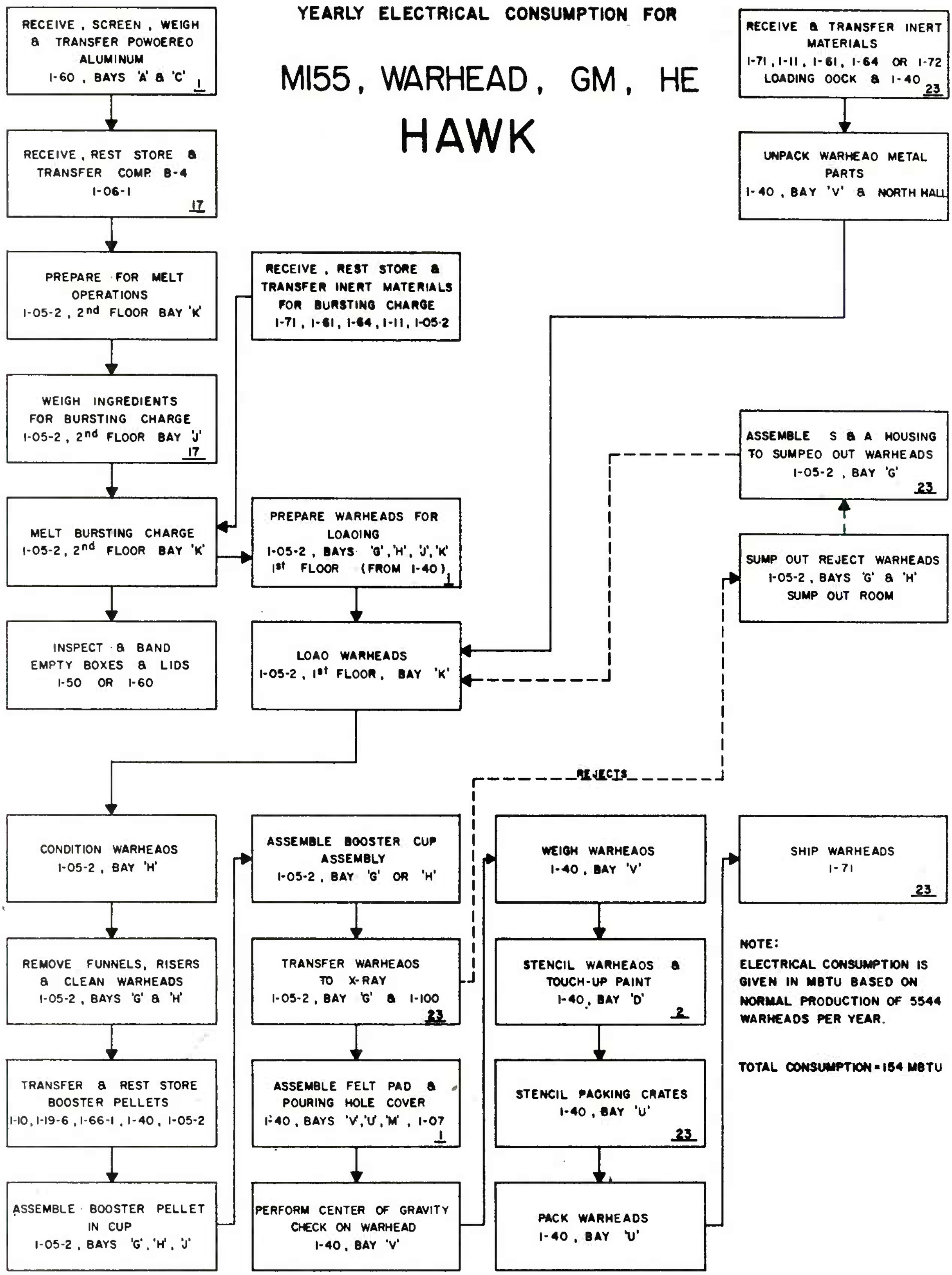


NOTE:
STEAM CONSUMPTION IS GIVEN IN MBTU BASED ON NORMAL PRODUCTION OF 5544 WARHEADS PER YEAR.

TOTAL CONSUMPTION = 1212 MBTU

YEARLY ELECTRICAL CONSUMPTION FOR

M155, WARHEAD, GM, HE HAWK



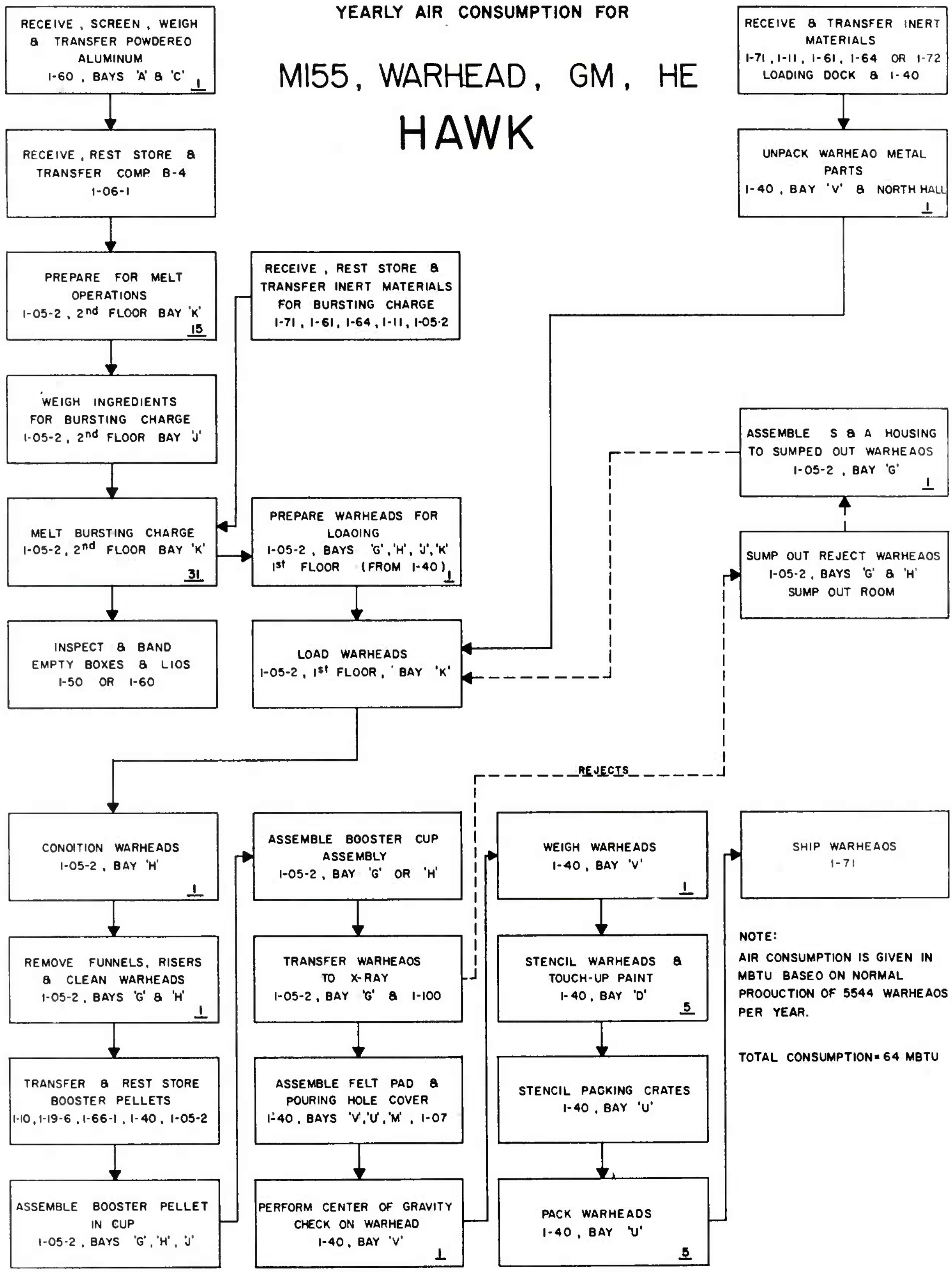
NOTE:
ELECTRICAL CONSUMPTION IS GIVEN IN MBTU BASED ON NORMAL PRODUCTION OF 5544 WARHEADS PER YEAR.

TOTAL CONSUMPTION = 154 MBTU

YEARLY AIR CONSUMPTION FOR

M155, WARHEAD, GM, HE

HAWK



NOTE:
AIR CONSUMPTION IS GIVEN IN MBTU BASED ON NORMAL PRODUCTION OF 5544 WARHEADS PER YEAR.

TOTAL CONSUMPTION = 64 MBTU

M258, HE, WARHEAD (STINGER)

PROCESS DESCRIPTION

The M258 (STINGER) is a missile warhead filled with approximately 1.5 pounds of HTA-3 explosive. A standard production rate of 5,040 warheads per year has been used in this report. The M258 is not included in the latest IAAP mobilization schedule.

The warhead metal parts are received at a load line storage building. The warheads are unpacked, prepared for loading and transferred to the melt building as needed. Explosive materials are received at various service magazines, then transferred to the melt building for processing as needed.

Warheads are preheated in an oven to 160°F to 180°F. HTA-3 is melted in a kettle with 15 psi steam to a temperature of 200°F. Approximately 1.5 pounds of HTA-3 is poured into the warheads and the warheads are allowed to cool for a minimum of four hours.

When cooled, the pellet cavity is drilled. The warheads are cleaned and transferred to x-ray. Accepted warheads are transferred to the assembly building. Rejects are returned to the melt building for sump out and reprocessing.

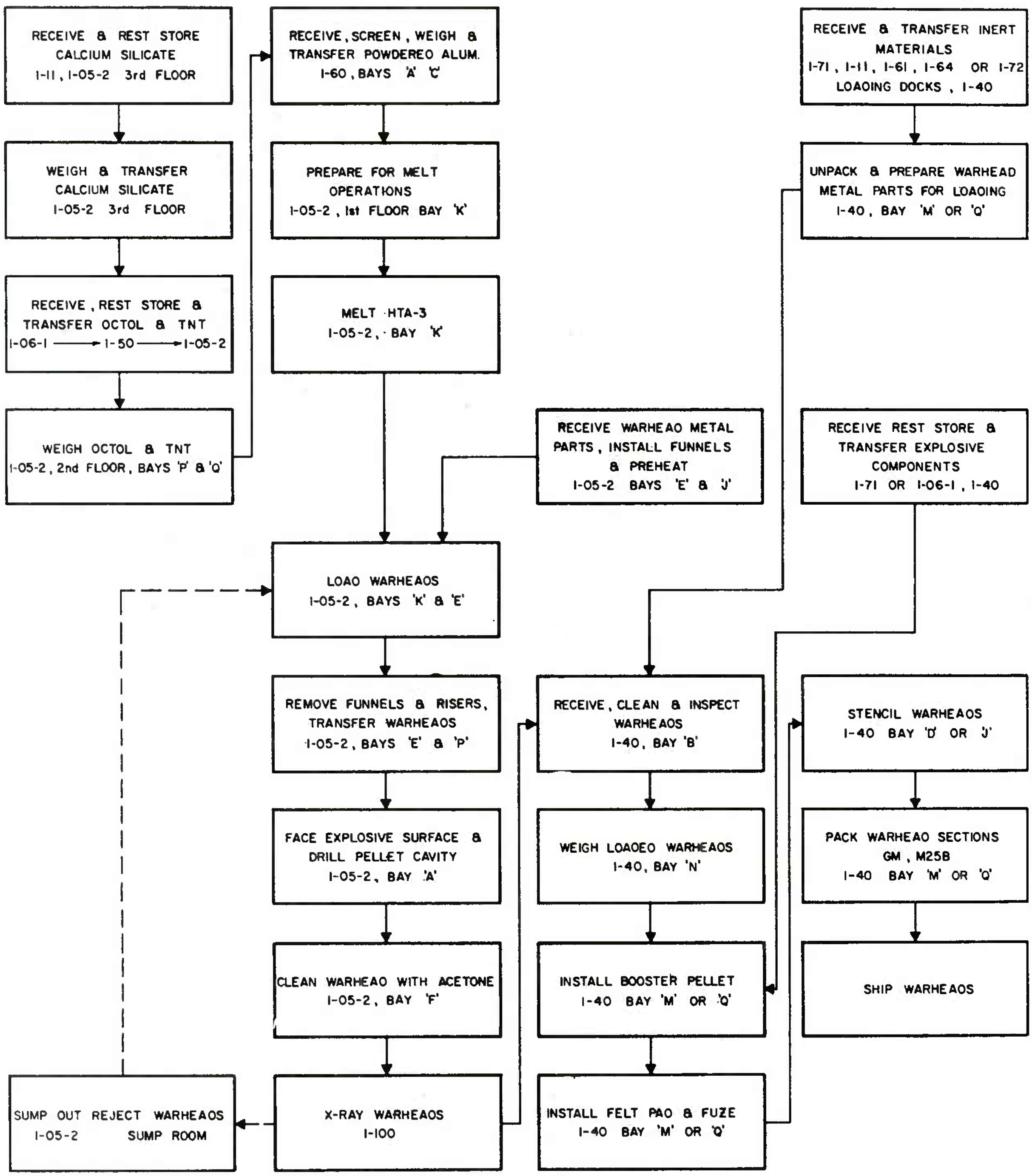
Accepted shells are cleaned, inspected and weighed. The booster pellets, felt pad and fuze are installed. The warheads are then stenciled, packed and shipped out.

The above description of the manufacturing process was extracted from the following Iowa Army Ammunition Plant Standing Operating Procedure:

S.O.P. No. 803 - Load, Assemble and Pack Warhead Section, GM, HE, M258

PROCESS FLOW FOR

M258, WARHEAD, GM, HE
STINGER



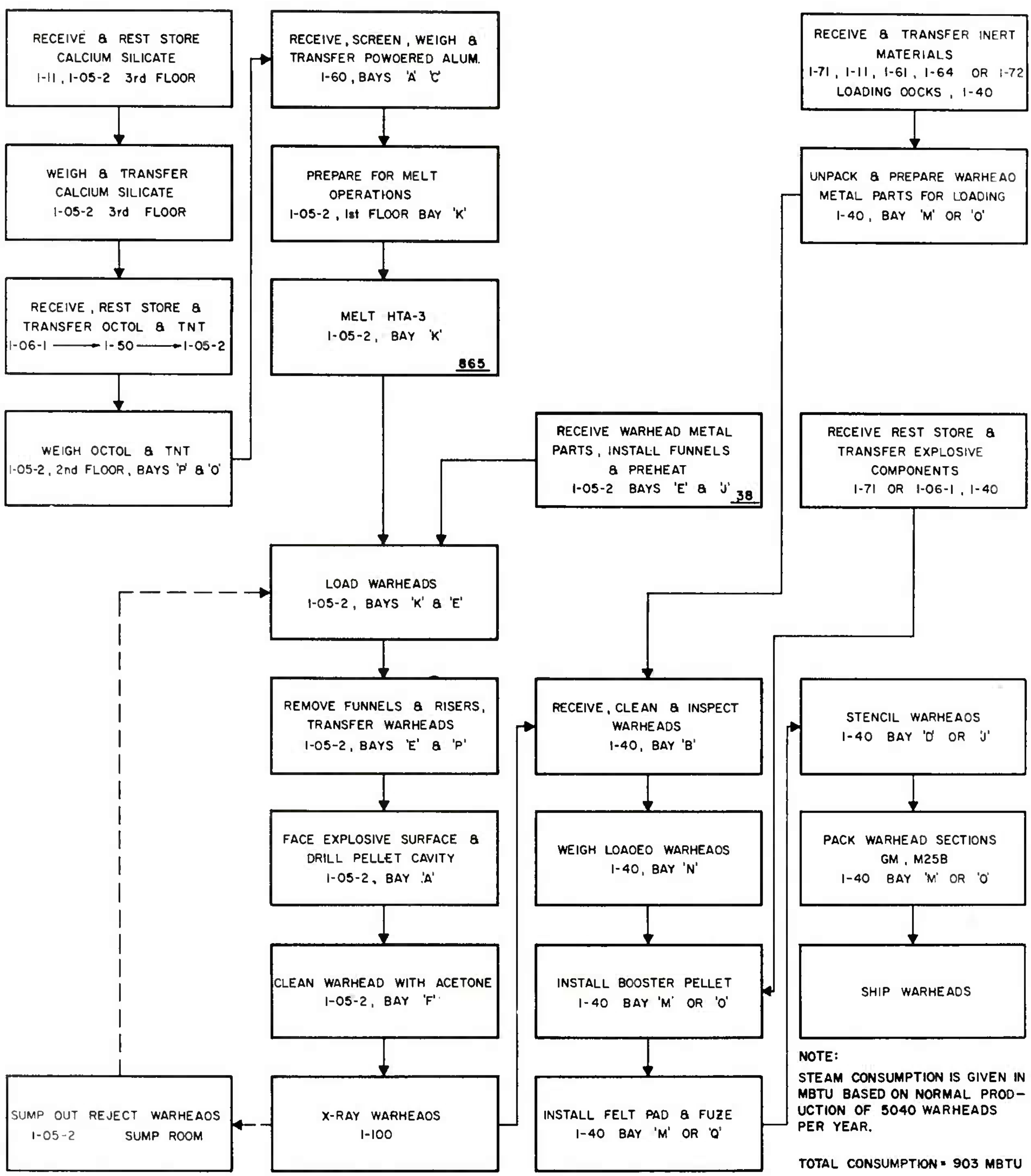
Energy Consumption

The process energy consumed in the L/A/P of the M258, HE Warhead (STINGER) totaled 1,105 MBTU per year at a production rate of 5,040 warheads per year, as produced at the Iowa Army Ammunition Plant. This amounts to 219,246 BTU per warhead.

The following charts show a breakdown of energy consumption by production step and form of energy.

YEARLY STEAM CONSUMPTION FOR

M258 , WARHEAD , GM , HE STINGER

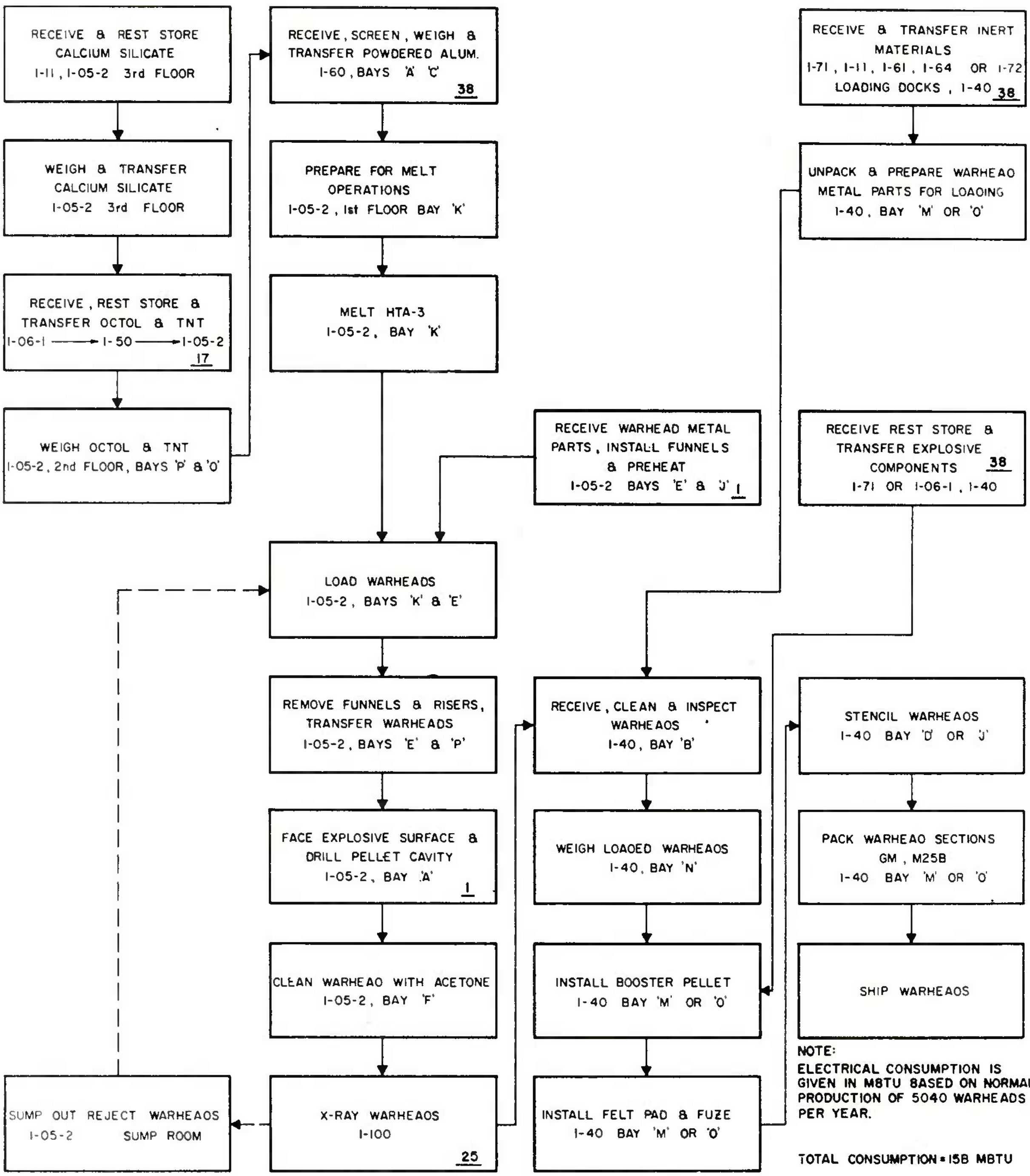


NOTE:
STEAM CONSUMPTION IS GIVEN IN MBTU BASED ON NORMAL PRODUCTION OF 5040 WARHEADS PER YEAR.

TOTAL CONSUMPTION = 903 MBTU

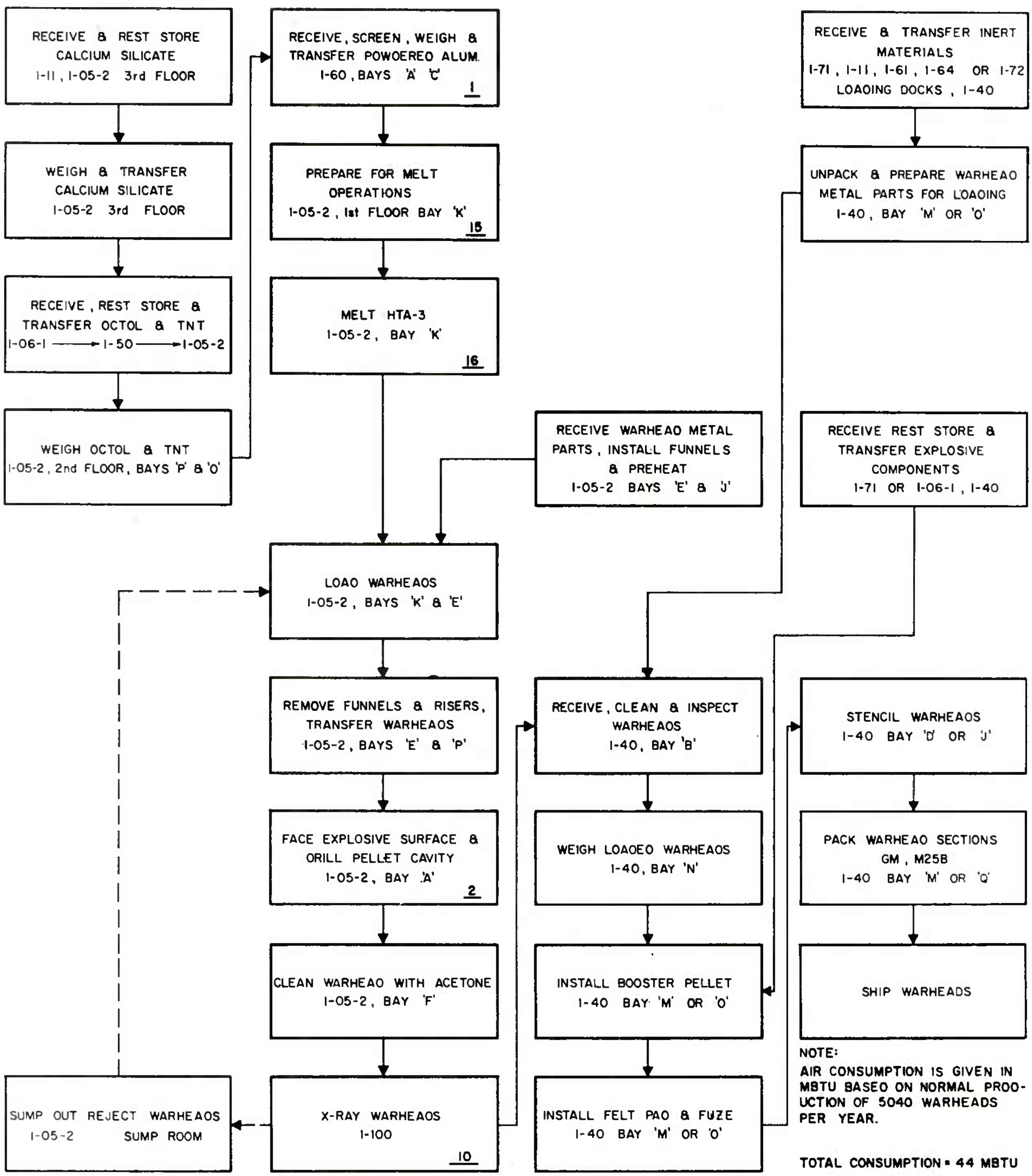
YEARLY ELECTRICAL CONSUMPTION FOR

M258, WARHEAD, GM, HE
STINGER



YEARLY AIR CONSUMPTION FOR

M258, WARHEAD, GM, HE
STINGER



NOTE:
AIR CONSUMPTION IS GIVEN IN MBTU BASED ON NORMAL PRODUCTION OF 5040 WARHEADS PER YEAR.

TOTAL CONSUMPTION = 44 MBTU

M250, HE, GM, Warhead (CHAPARRAL)

PROCESS DESCRIPTION

The M250 (CHAPARRAL) is a missile warhead filled with approximately 1.5 pounds of Octol explosive. A standard production rate of 12,096 warheads per year has been used in this report. The M250 is not included in the latest IAAP mobilization schedule.

The warhead metal parts are received at a load line storage building. The warheads are unpacked and prepared for loading. The interiors of the warheads are painted and the warheads are transferred to the melt building as needed. Explosive materials are received at various service magazines, then transferred to the melt building for processing as needed.

The warheads are preheated in an oven to a minimum of 160°F. Octol is melted in a kettle with 15 psi steam to a temperature of 195°F ± 5°F. Approximately 1.5 pounds of Octol is poured into each warhead. The warheads are then probed with a 220°F minimum probe finger to a depth of 3/4 inch for one hour and 45 minutes. The warheads are allowed to cool for a minimum of two hours.

When cooled, the cushion cavity is drilled. The warheads are cleaned, weighed and transferred to x-ray. The accepted warheads are transferred to the assembly building, rejects are returned to the melt building for reprocessing.

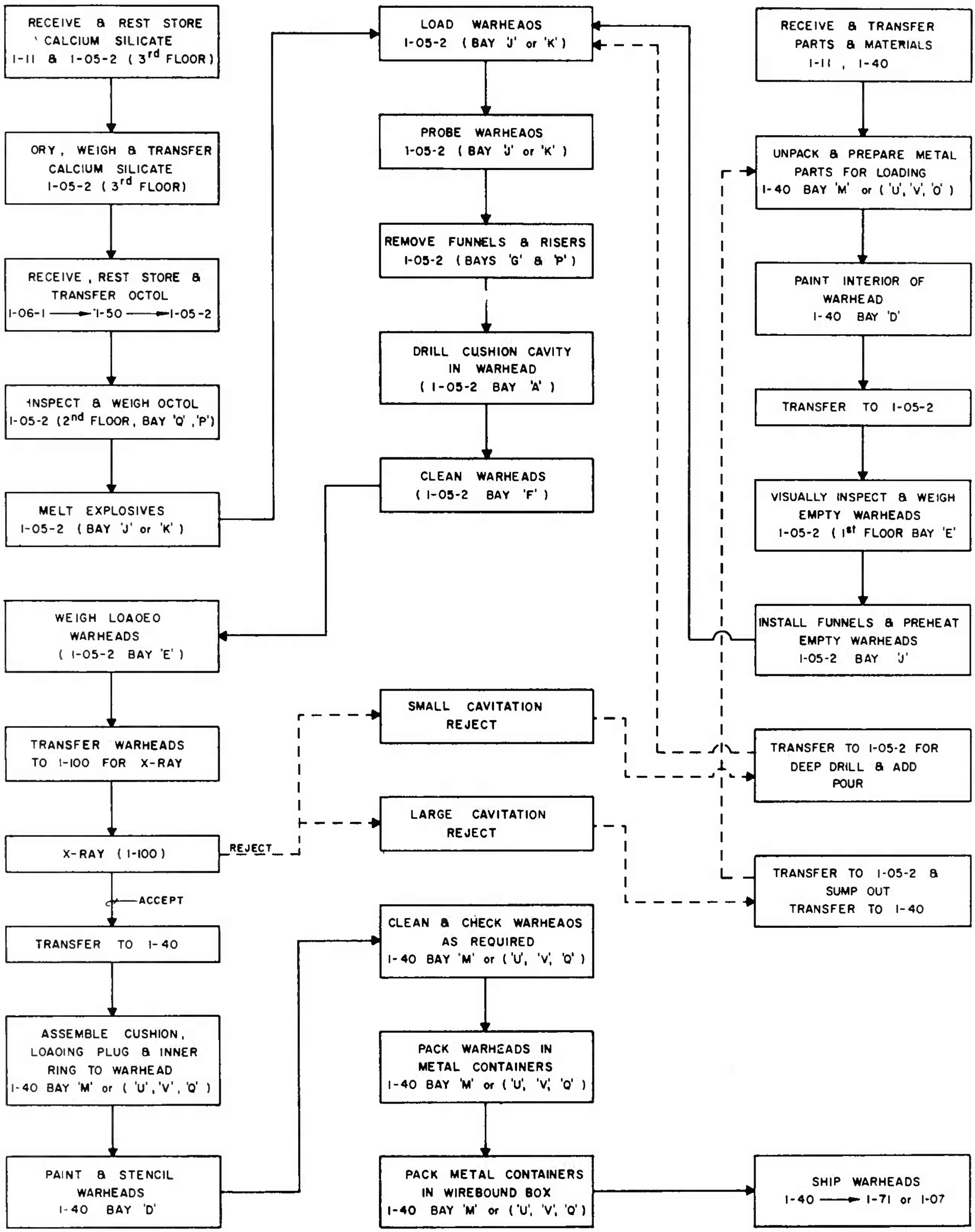
The cushion, loading plug and inner ring to the warhead are assembled. The warheads are painted, stenciled and cleaned as required. The warheads are packed and shipped out.

The above description of the manufacturing process was extracted from the following Iowa Army Ammunition Plant Standing Operating Procedure:

S.O.P No. 795 - Load, Assemble and Pack Warhead, GM, HE, M250

PROCESS FLOW FOR

CHAPARRAL, GM, HE, M250



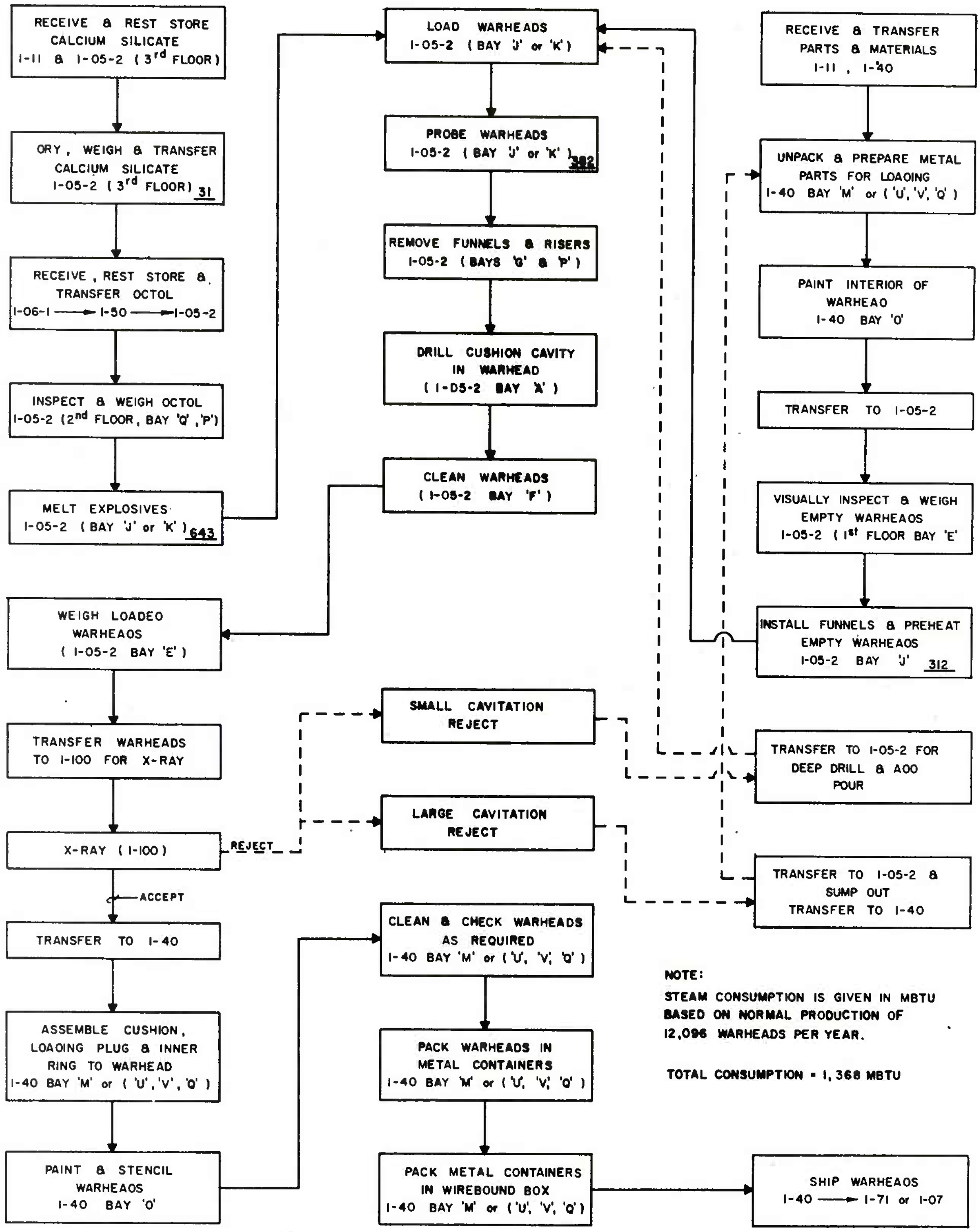
Energy Consumption

The process energy consumed in the L/A/P of the M250, HE, GM Warhead (CHAPARRAL) totaled 1,578 MBTU per year at a production rate of 12,096 warheads per year, as produced at the Iowa Army Ammunition Plant. This amounts to 130,456 BTU per warhead.

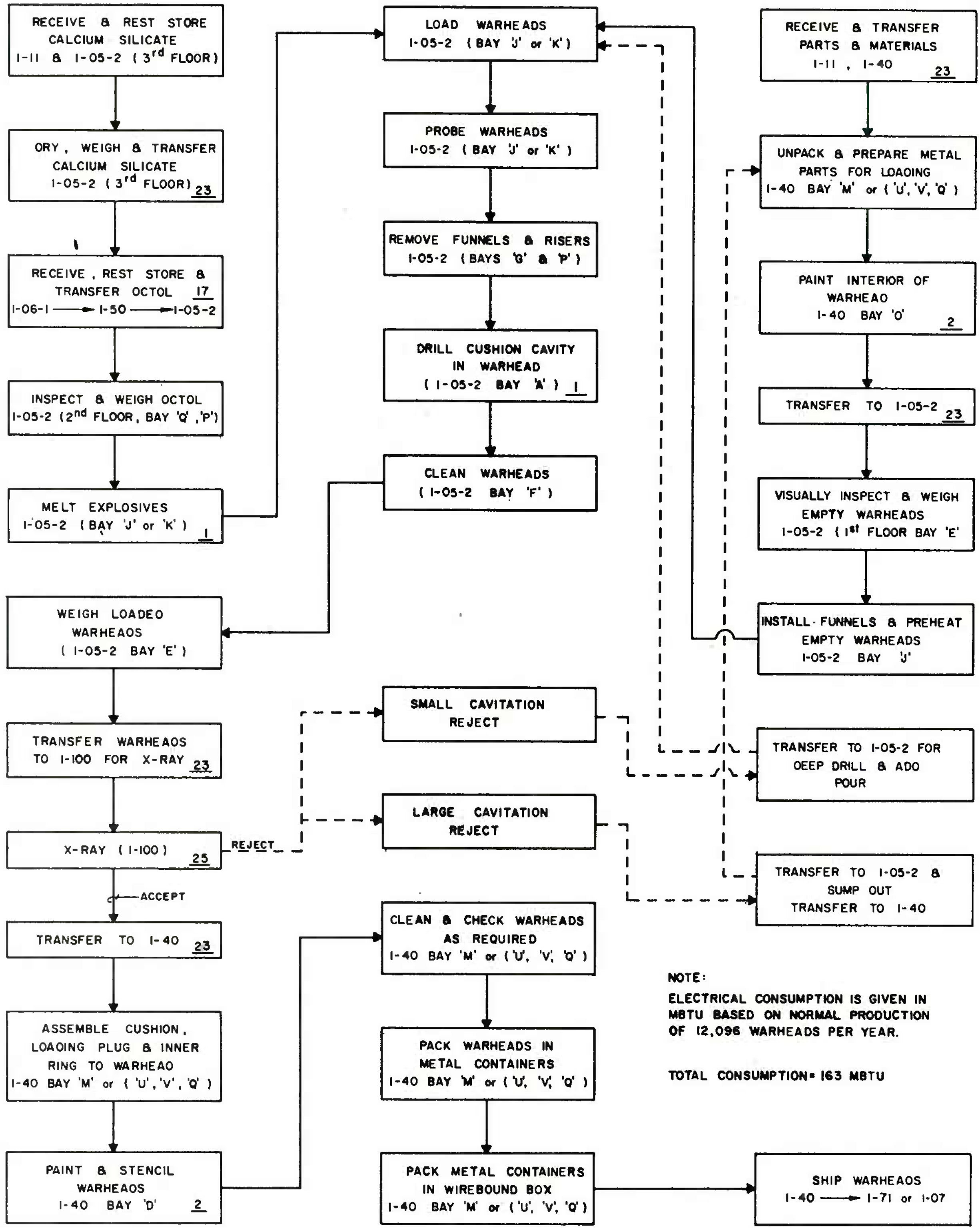
The following charts show a breakdown of energy consumption by production step and form of energy.

YEARLY STEAM CONSUMPTION FOR

CHAPARRAL, GM, HE, M250

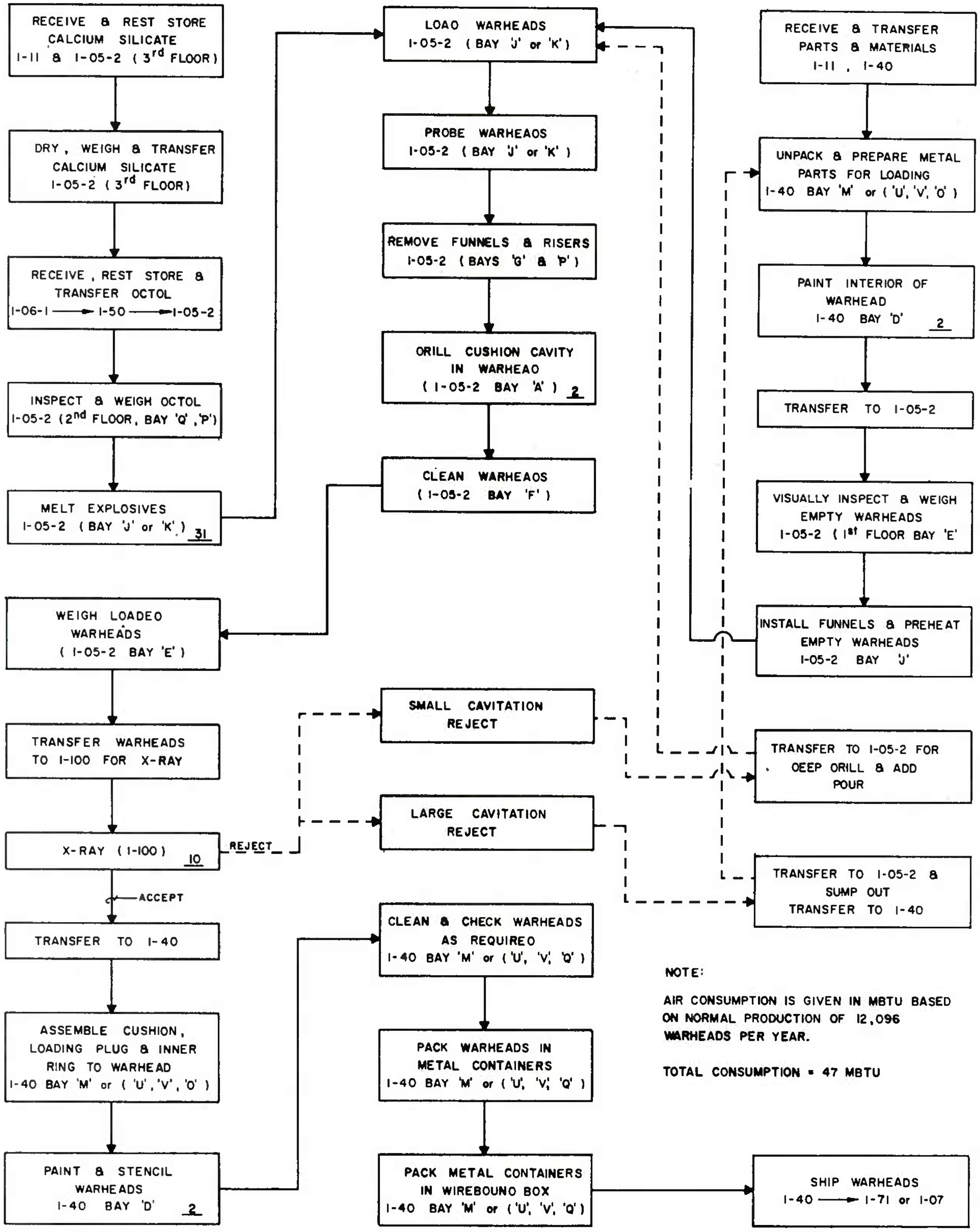


YEARLY ELECTRICAL CONSUMPTION FOR
CHAPARRAL, GM, HE, M250



YEARLY AIR CONSUMPTION FOR

CHAPARRAL, GM, HE, M250



NOTE:

AIR CONSUMPTION IS GIVEN IN MBTU BASED ON NORMAL PRODUCTION OF 12,096 WARHEADS PER YEAR.

TOTAL CONSUMPTION = 47 MBTU

M225, HE, GM, Warhead (DRAGON)

PROCESS DESCRIPTION

The M225 (DRAGON) is a missile warhead filled with approximately 5 pounds of Octol and TNT explosive. A standard production rate of 12,000 warheads per year has been used in this report. The mobilization production rate according to the latest IAAP mobilization schedule is 21,600 warheads per year.

The warhead metal parts are received at a load line storage building. The warheads are unpacked, prepared for loading and transferred to the melt building as needed. Explosive materials are received at various service magazines, then transferred to the melt building for processing as needed.

Warheads are preheated in an oven to a minimum of 190°F. Octol and TNT are melted to a temperature of 210°F ± 5°F. Approximately 5 pounds of Octol and TNT are poured into each warhead. The warheads are conditioned in a conditioning chest with steam (15 psi) and hot water (125°F ± 10°F) for a total of 9½ hours.

When cooled, the pellet cavity is drilled and the booster pellet is installed.

The warheads are transferred to x-ray. Accepted warheads are transferred to the assembly building; rejects are returned to the melt building for reprocessing.

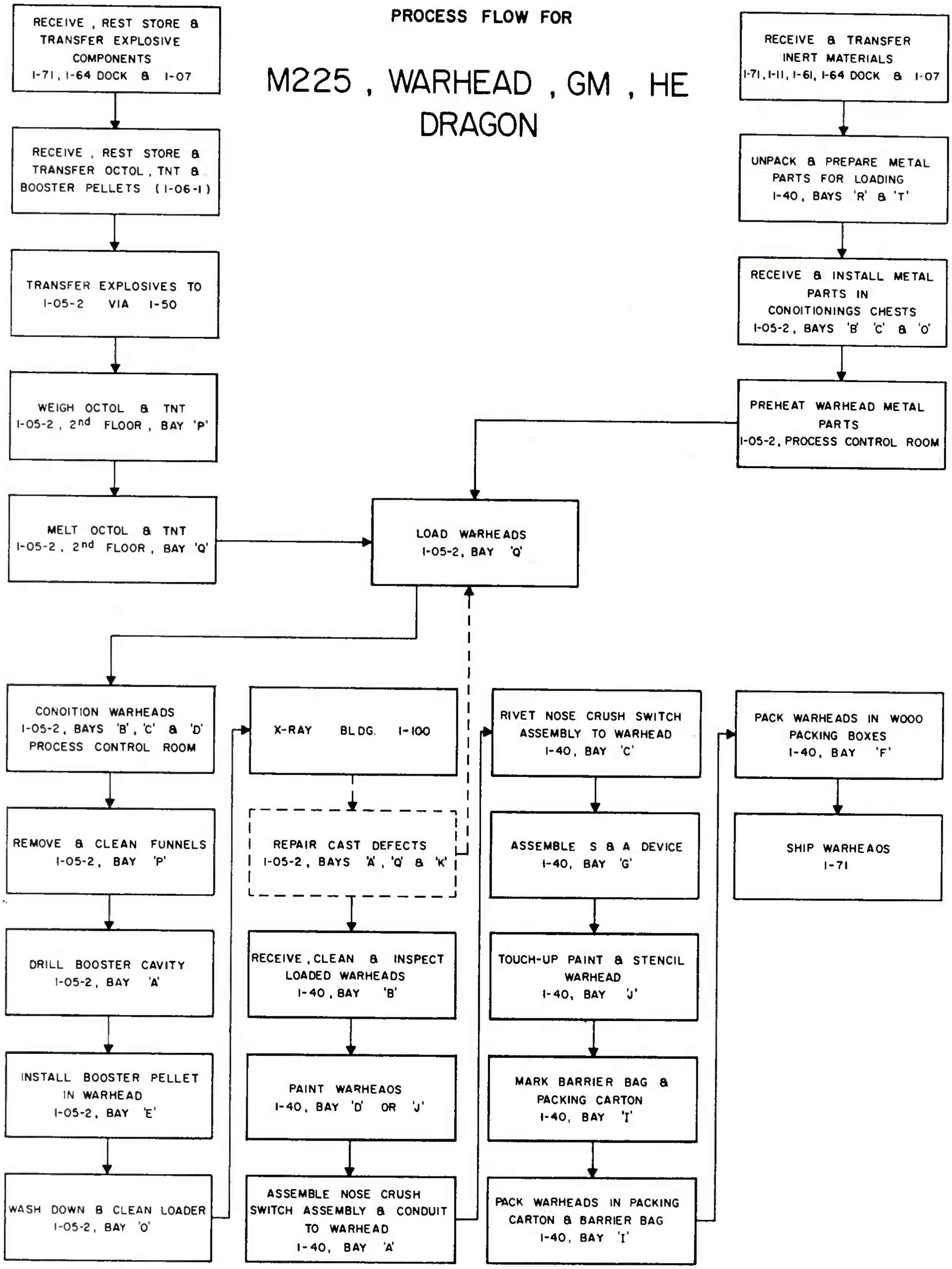
Accepted warheads are cleaned, inspected and painted. The nose crush switch and S&A device assemblies are attached to the warheads. The warheads are stenciled, packed and shipped.

The above description of the manufacturing process was extracted from the following Iowa Army Ammunition Plant Standing Operating Procedure:

S.O.P. No. 713 - Load Warhead Section, GM, HE, M225

PROCESS FLOW FOR

M225, WARHEAD, GM, HE DRAGON



Energy Consumption

The process energy consumed in the L/A/P of the M225, HE, GM Warhead (DRAGON) totaled 1,041 MBTU at a production rate of 12,000 warheads per year, as produced at the Iowa Army Ammunition Plant. Planned mobilization production of 21,600 warheads per year would consume 1,365 MBTU per year. This amounts to 86,750 BTU per warhead at standard production and 63,194 BTU per warhead at mobilization.

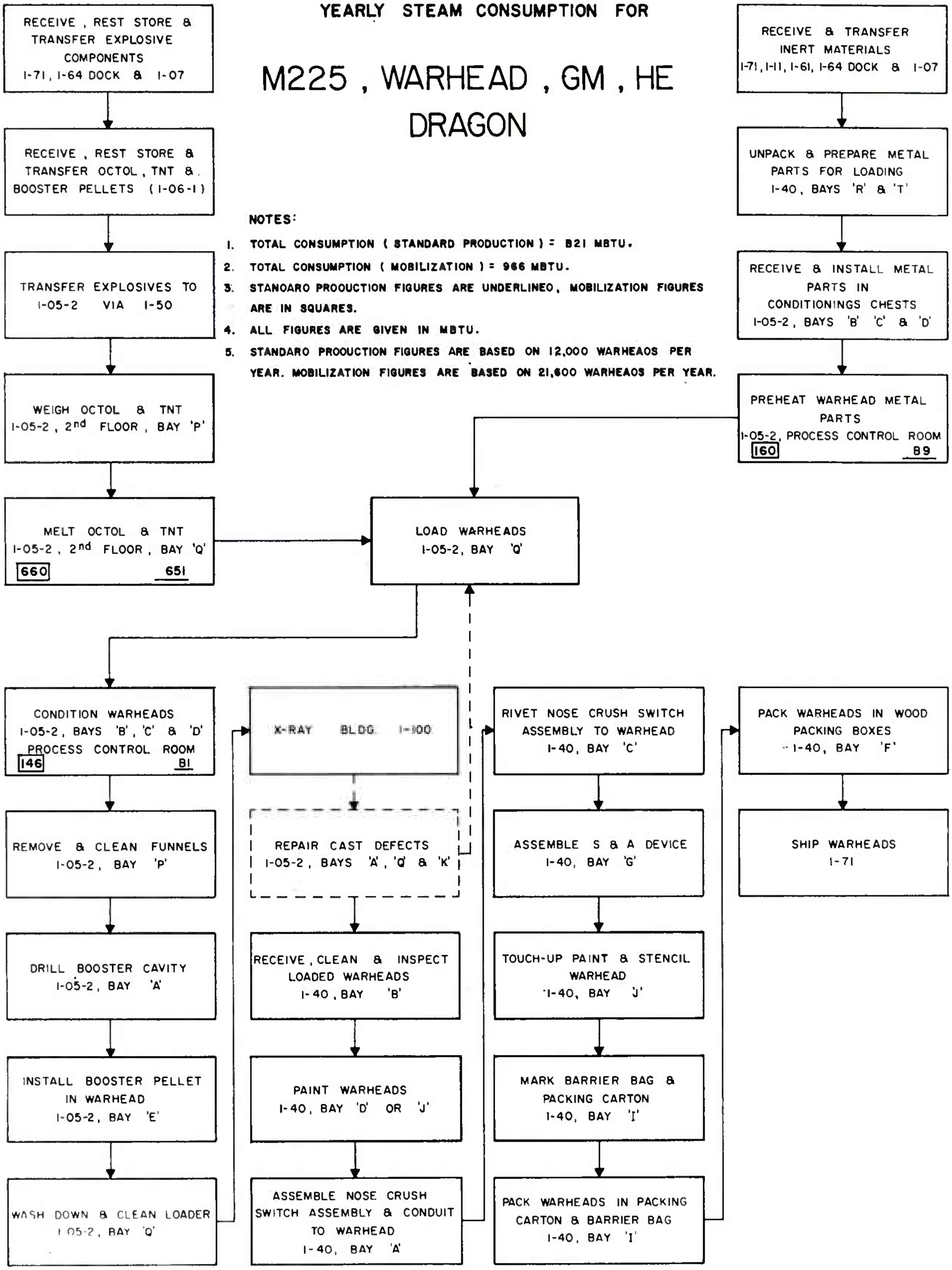
The following charts show a breakdown of energy consumption by production step and form of energy.

YEARLY STEAM CONSUMPTION FOR

M225, WARHEAD, GM, HE DRAGON

NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 821 MBTU.
2. TOTAL CONSUMPTION (MOBILIZATION) = 966 MBTU.
3. STANDARD PRODUCTION FIGURES ARE UNDERLINED, MOBILIZATION FIGURES ARE IN SQUARES.
4. ALL FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 12,000 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 21,600 WARHEADS PER YEAR.

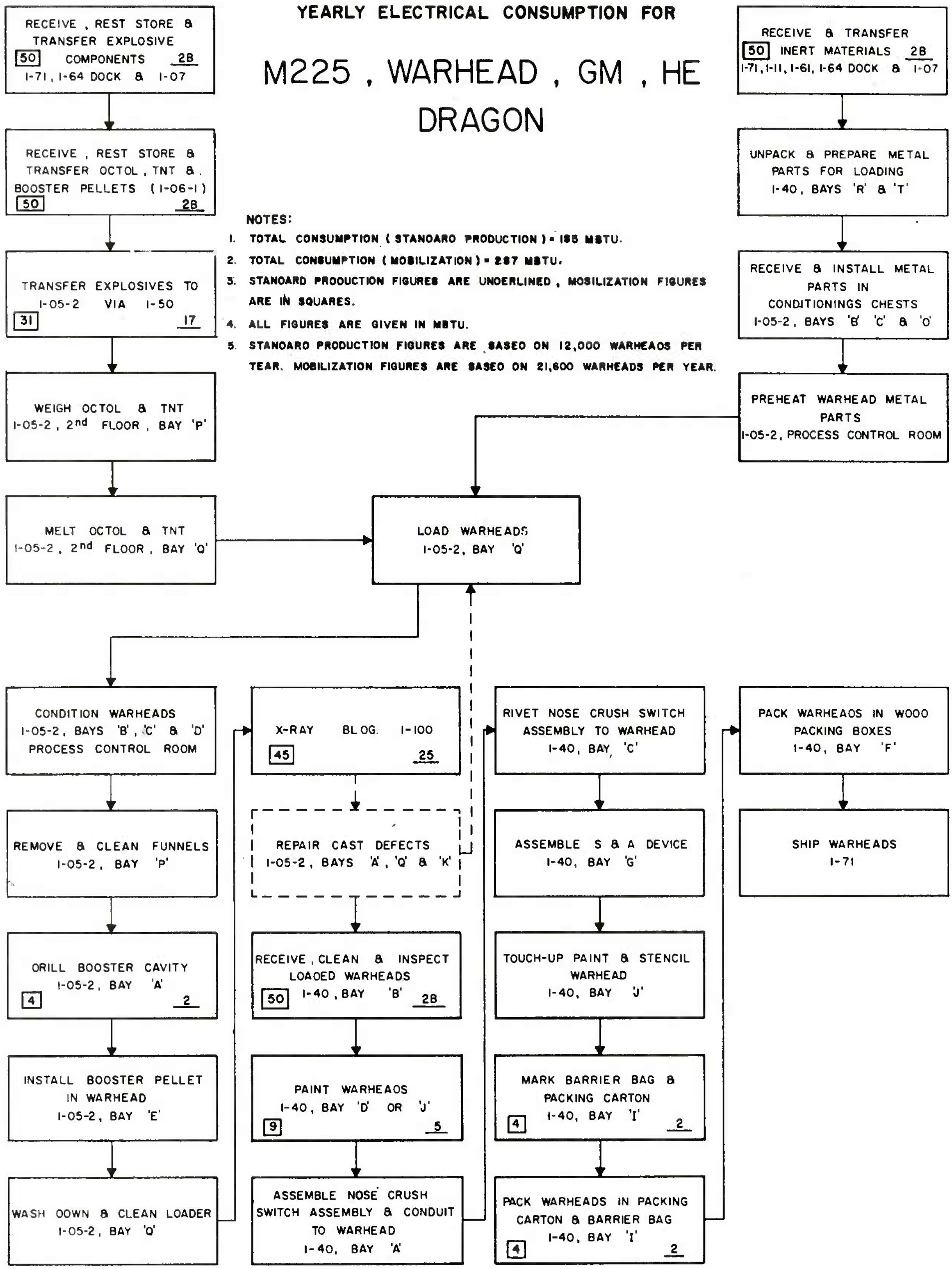


YEARLY ELECTRICAL CONSUMPTION FOR

M225, WARHEAD, GM, HE DRAGON

NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 185 MBTU.
2. TOTAL CONSUMPTION (MOBILIZATION) = 287 MBTU.
3. STANDARD PRODUCTION FIGURES ARE UNDERLINED, MOBILIZATION FIGURES ARE IN SQUARES.
4. ALL FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 12,000 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 21,600 WARHEADS PER YEAR.

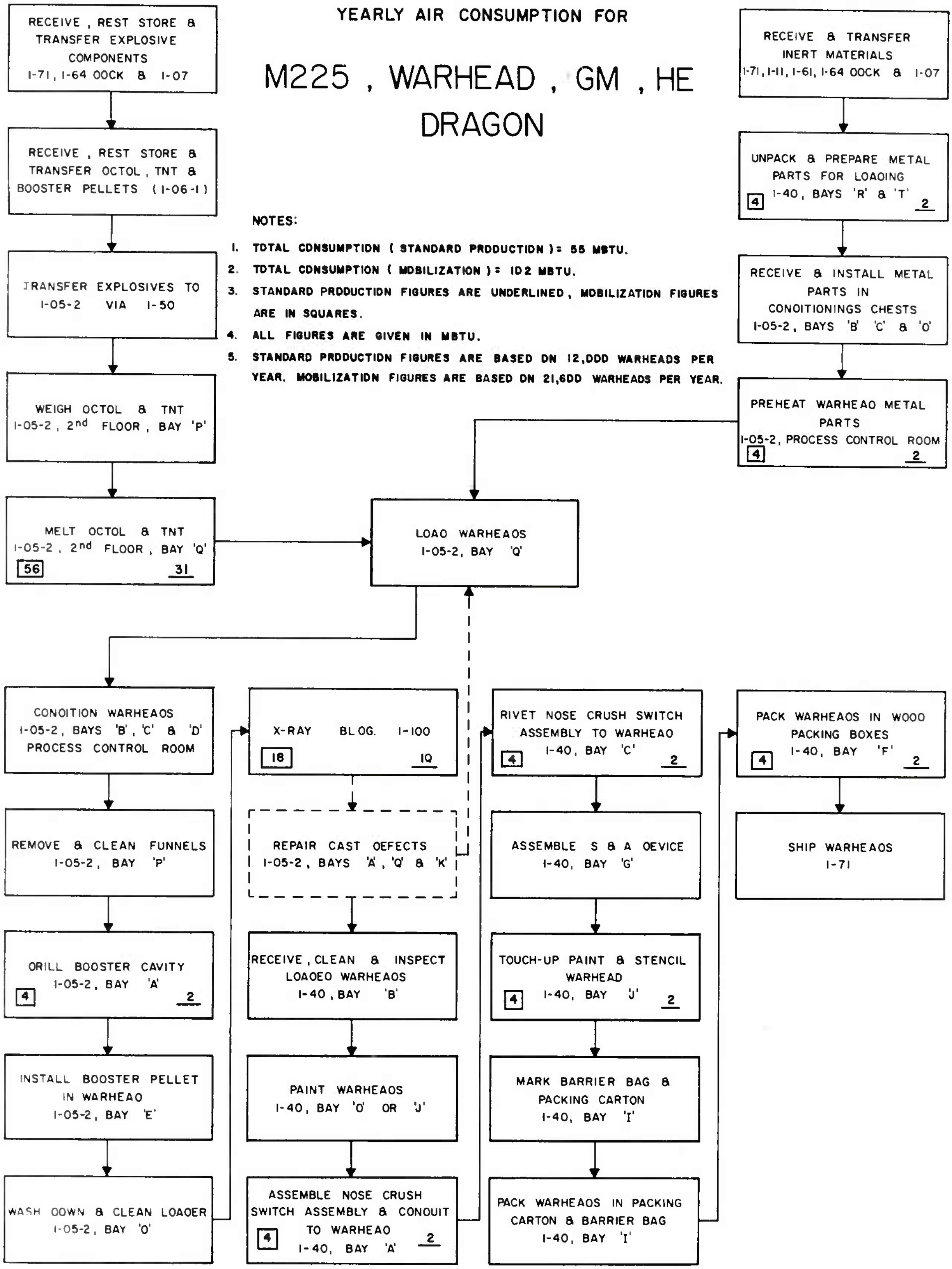


YEARLY AIR CONSUMPTION FOR

M225, WARHEAD, GM, HE DRAGON

NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 55 MBTU.
2. TOTAL CONSUMPTION (MOBILIZATION) = 102 MBTU.
3. STANDARD PRODUCTION FIGURES ARE UNDERLINED, MOBILIZATION FIGURES ARE IN SQUARES.
4. ALL FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 12,000 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 21,600 WARHEADS PER YEAR.



M712, HE, GM, Warhead (COPPERHEAD)

PROCESS DESCRIPTION

The M712 (COPPERHEAD) is a guided missile warhead filled with approximately 18 pounds of Composition B explosive. A standard production rate of 9,576 warheads per year has been used in this report. The mobilization production rate according to the latest IAAP mobilization schedule, is 19,200 warheads per year.

The warhead metal parts are received at a load line storage building. The warheads are unpacked, inspected, weighed and transferred to the melt building as needed. Explosive materials are received at various service magazines and transferred to the melt building as needed.

The warheads are preheated in a conditioning chest to a minimum of 125°F. Composition B is melted to a temperature of 193°F ± 4°F. Approximately 18 pounds of Composition B are poured into each warhead. The warheads are conditioned in a conditioning chest with steam (15 psi) and cooling water (90°F ± 3°F) for 9 hours.

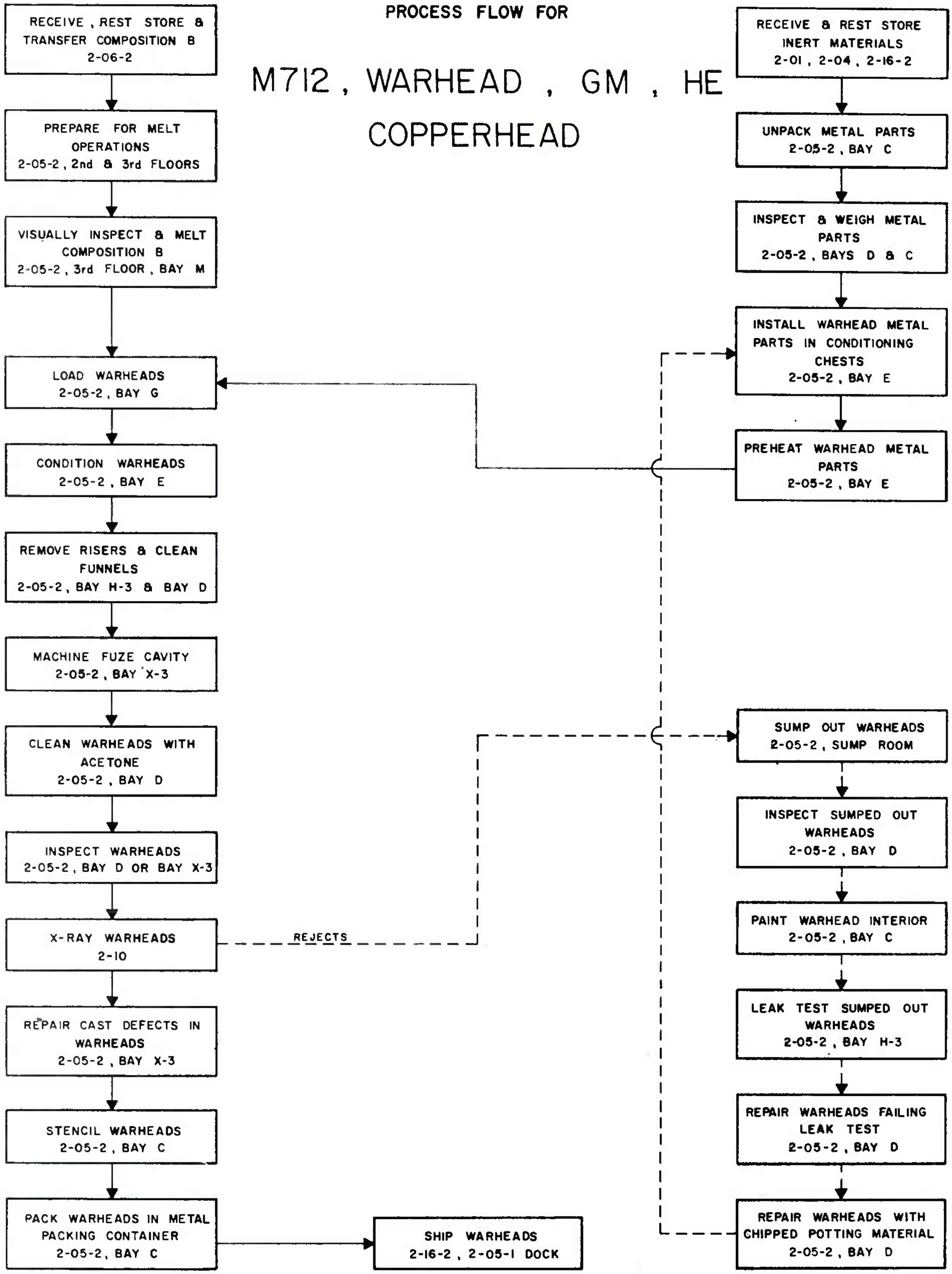
When cooled, the fuze cavity is machined, the warheads cleaned and transferred to x-ray. Rejected warheads are transferred to the melt building for reprocessing. Accepted warheads are packed and shipped.

The above description of the manufacturing process was extracted from the following Iowa Army Ammunition Plant Standing Operating Procedure:

S.O.P. No. 807, Rev. 1 - Load, Assemble and Pack Warhead, GM, HE, M712 Copperhead

PROCESS FLOW FOR

M712, WARHEAD, GM, HE COPPERHEAD



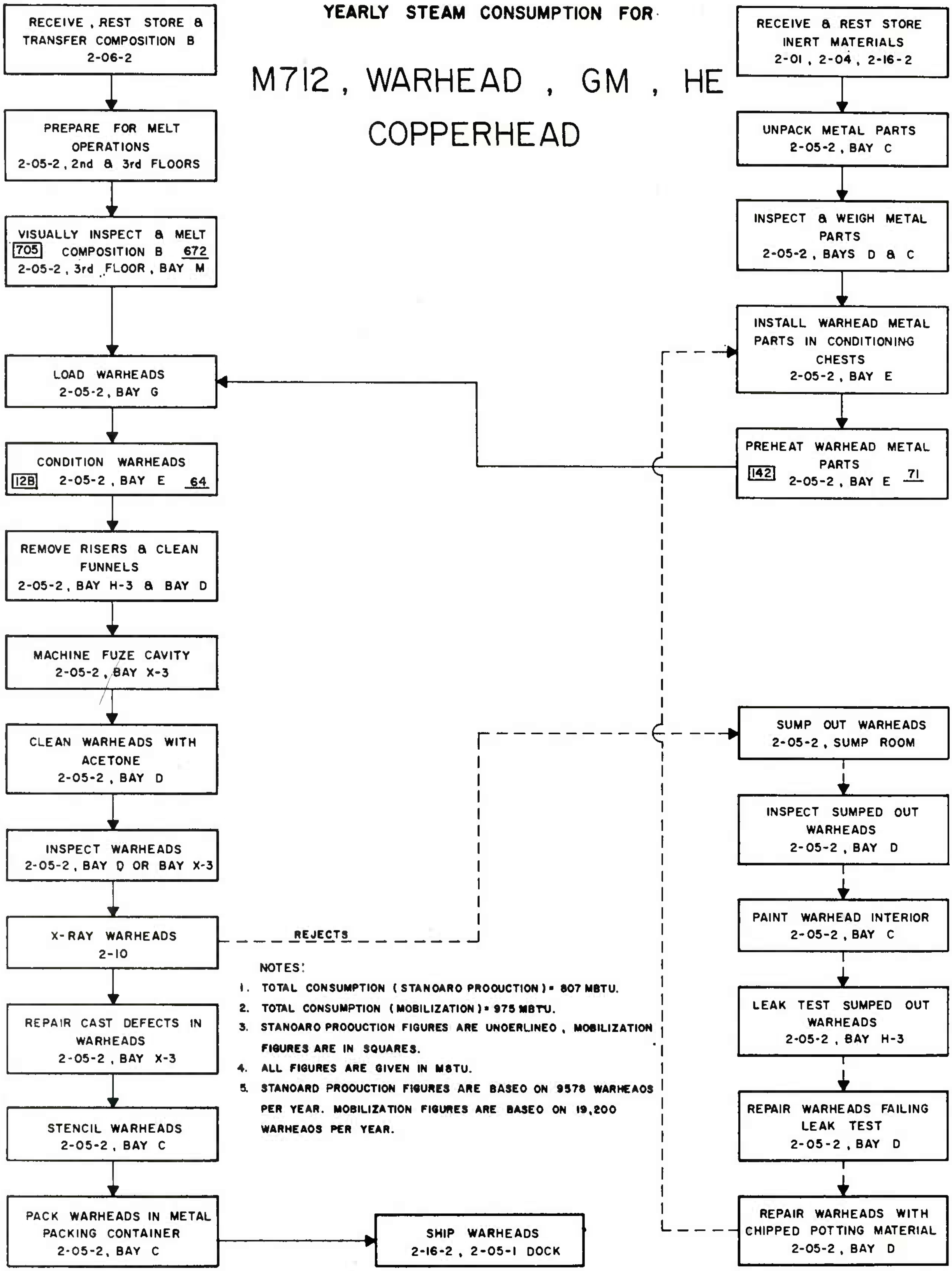
Energy Consumption

The process energy consumed in the L/A/P of the M712, HE, GM Warhead (COPPERHEAD) totaled 1,012 MBTU at a production rate of 9,576 warheads per year, as produced at the Iowa Army Ammunition Plant. Planned mobilization production of 19,200 warheads per year would consume 1,385 MBTU per year. This amounts to 105,681 BTU per warhead at standard production and 72,135 BTU per warhead at mobilization.

The following charts show a breakdown of energy consumption by production step and form of energy.

YEARLY STEAM CONSUMPTION FOR

M712, WARHEAD, GM, HE COPPERHEAD

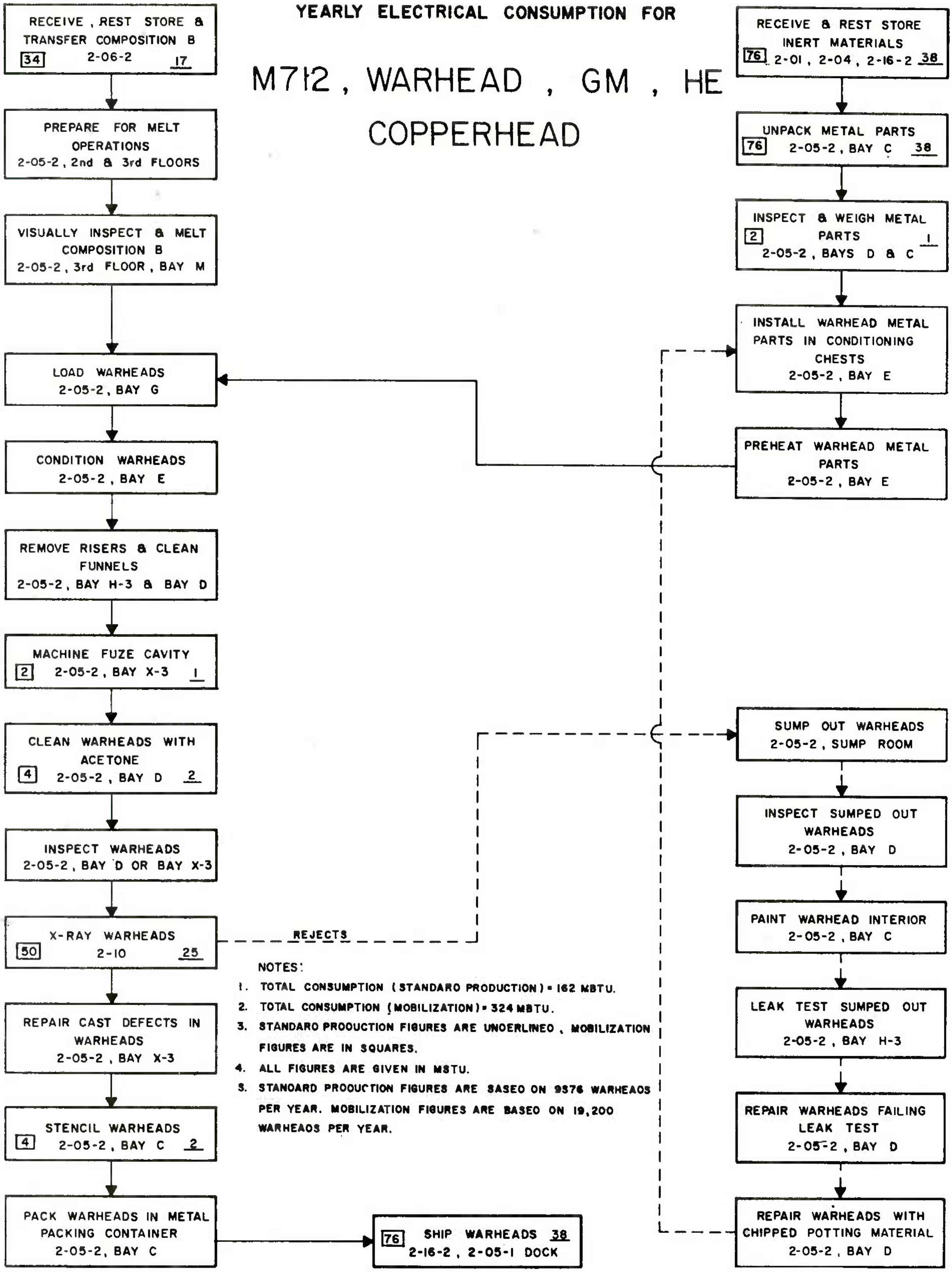


NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 807 MBTU.
2. TOTAL CONSUMPTION (MOBILIZATION) = 975 MBTU.
3. STANDARD PRODUCTION FIGURES ARE UNDERLINED, MOBILIZATION FIGURES ARE IN SQUARES.
4. ALL FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 9578 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 19,200 WARHEADS PER YEAR.

YEARLY ELECTRICAL CONSUMPTION FOR

M712, WARHEAD, GM, HE COPPERHEAD

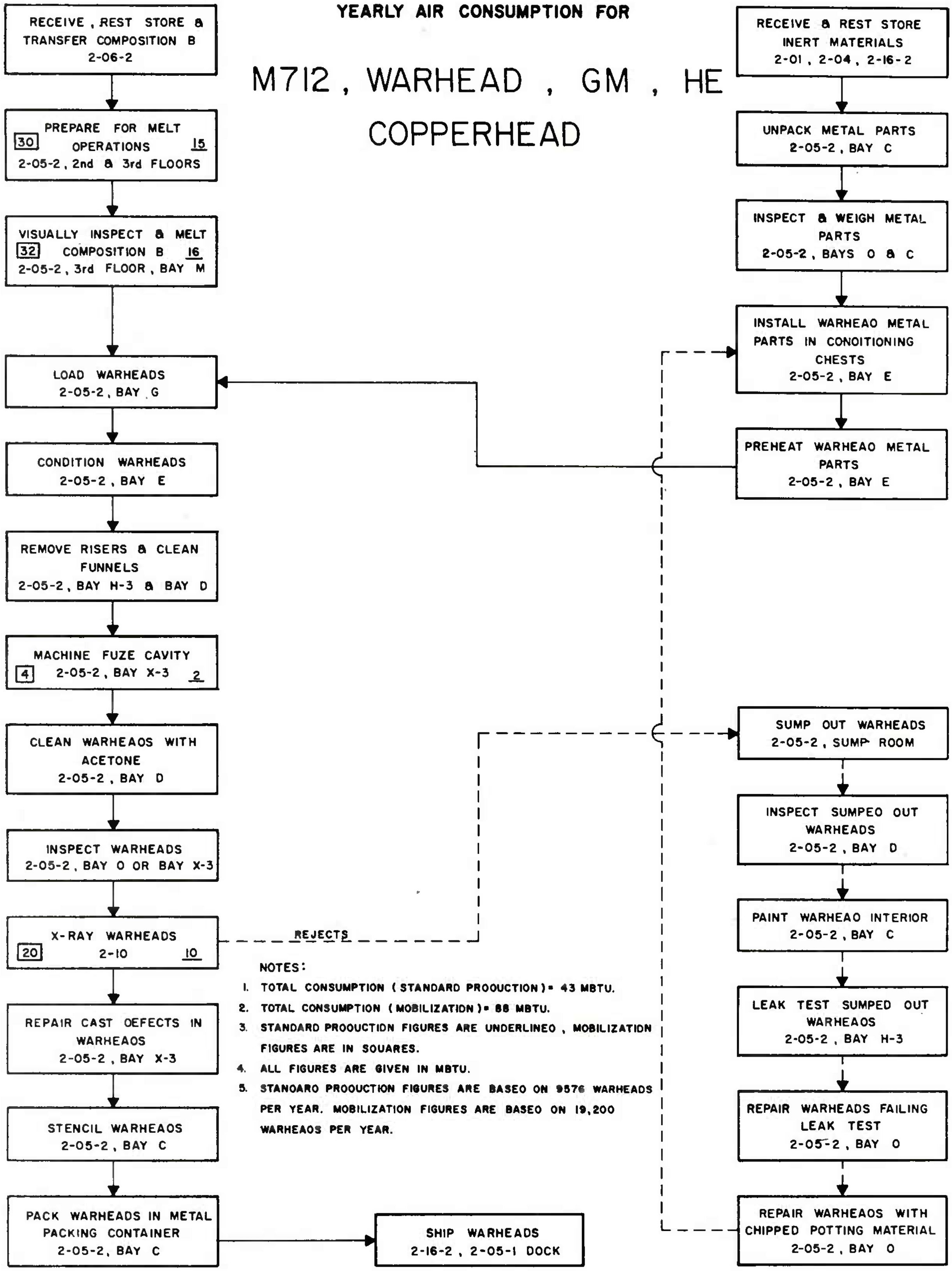


NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 162 MBTU.
2. TOTAL CONSUMPTION (MOBILIZATION) = 324 MBTU.
3. STANDARD PRODUCTION FIGURES ARE UNDERLINED, MOBILIZATION FIGURES ARE IN SQUARES.
4. ALL FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 9376 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 19,200 WARHEADS PER YEAR.

YEARLY AIR CONSUMPTION FOR

M712, WARHEAD, GM, HE COPPERHEAD



NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 43 MBTU.
2. TOTAL CONSUMPTION (MOBILIZATION) = 88 MBTU.
3. STANDARD PRODUCTION FIGURES ARE UNDERLINED, MOBILIZATION FIGURES ARE IN SQUARES.
4. ALL FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 9576 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 19,200 WARHEADS PER YEAR.

M207E1, HE, WARHEAD SECTION (I-TOW)

PROCESS DESCRIPTION

The M207E1 (I-TOW) Warhead is a pressed billet containing approximately 4.5 pounds of LX-14-0 explosive. A standard production rate of 38,808 warheads per year has been used in this report. The mobilization production rate, according to the latest IAAP mobilization schedule, is 54,000 warheads per year.

The warhead inert materials are received at a load line storage building and are transferred to their designated storage location in the press building. Explosive materials are received at service magazines, then transferred to the press building for processing as needed.

LX-14-0 is preheated in electrically operated ovens to a temperature of 230°F. Press tooling is preheated by hot water to a temperature of 230°F. Billets are pressed and allowed to cool for a minimum of one shift, then are transferred to conditioning ovens. Conditioning cycle consists of alternating periods at 160°F and at ambient temperature, taking place over a two day span.

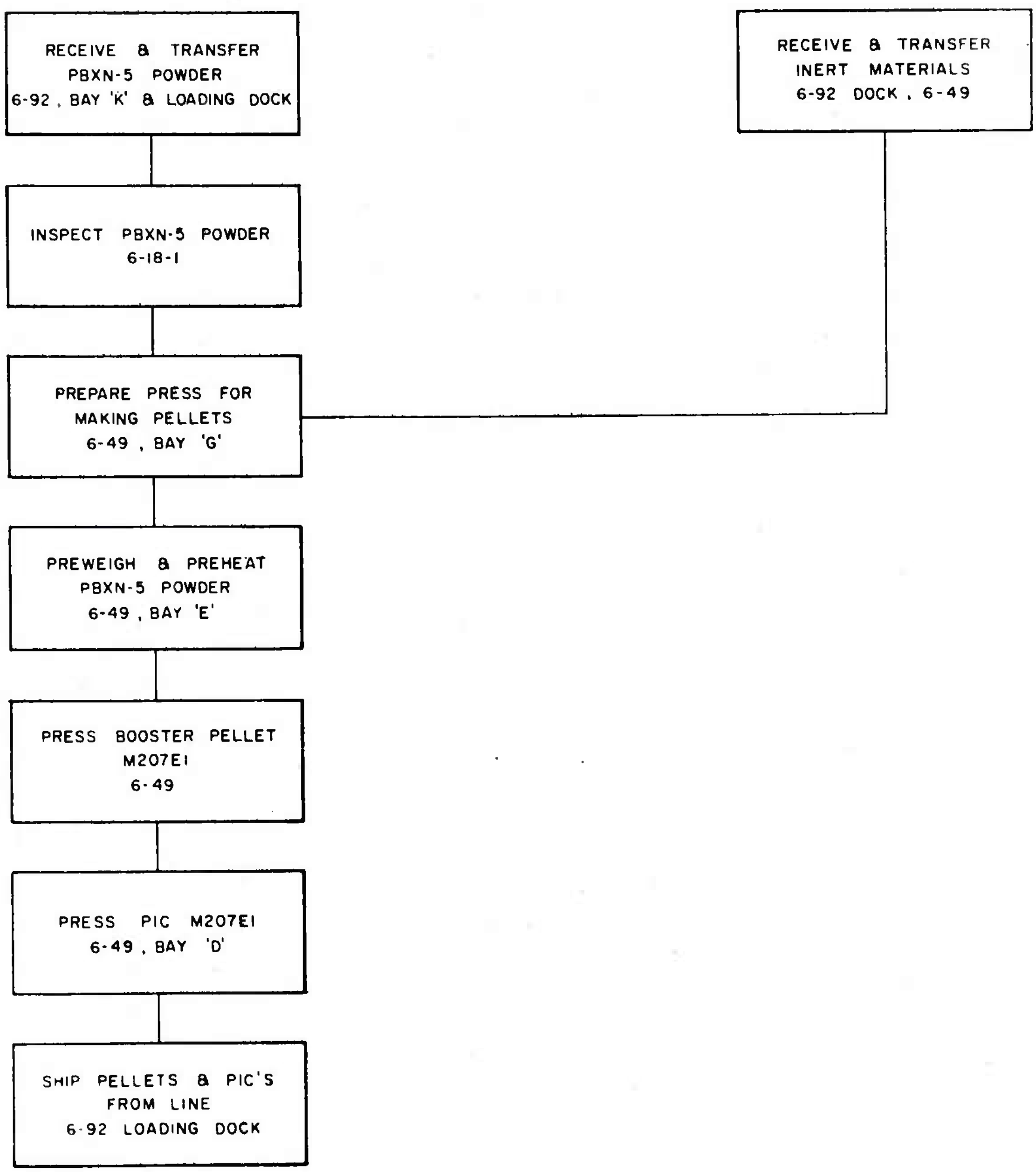
Conditioned billets are bonded to warhead body; initiation train is assembled to body. Warhead subassemblies are transferred to x-ray.

After x-ray, the warhead subassemblies are transferred to final assembly area, where fuze probe assembly is completed. Accepted warheads are stenciled, packed and shipped out.

This process description was extracted from IAAP Standing Operating Procedure No. 804, Press, Assemble, Pack and Ship I-TOW Warhead Section, GM, M207E1.

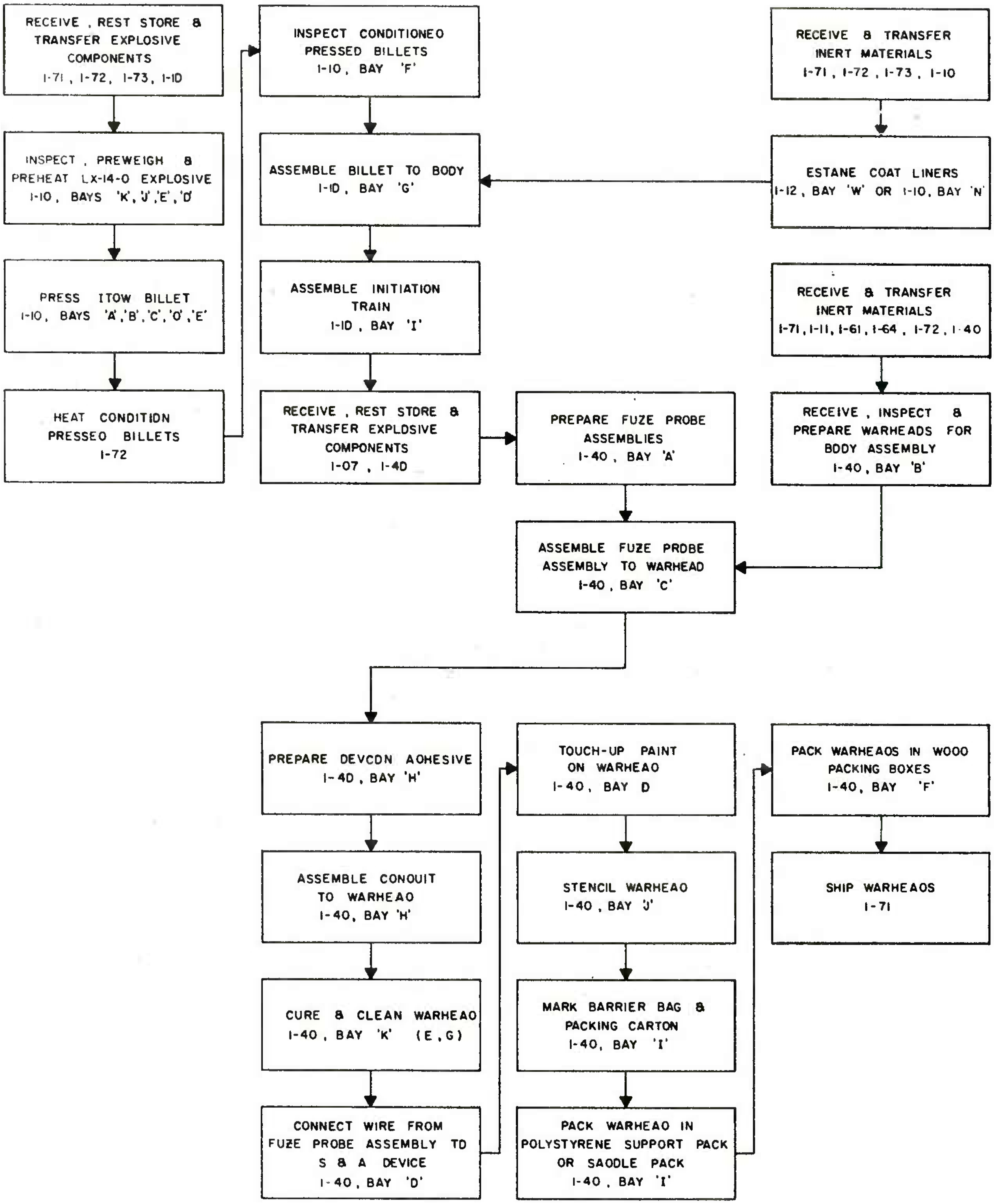
PROCESS FLOW FOR

M207E1, WARHEAD, GM, HE
ITOW



PROCESS FLOW FOR

M207E1, WARHEAD, GM, HE ITOW



Energy Consumption

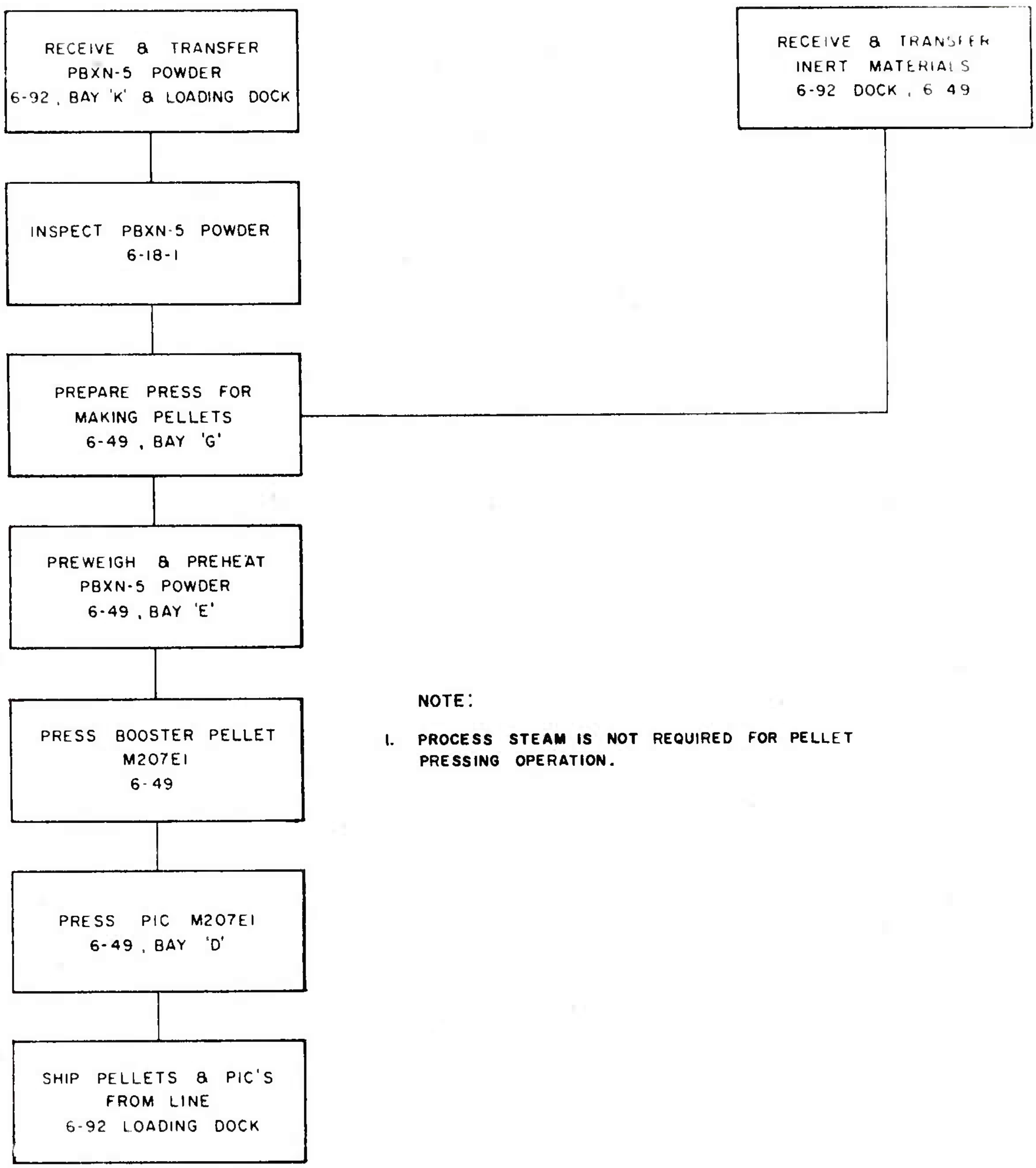
The process energy consumed in the production of the M207E1, HE Warhead (I-TOW) totaled 1,797 MBTU per year at a production rate of 38,808 warheads per year as produced at the Iowa Army Ammunition Plant. This is equivalent to 46,297 BTU per warhead. Planned mobilization production of 54,000 warheads per year would consume 2,500 MBTU per year.

The following charts show a breakdown of energy consumption by production step and form of energy.

The energy required to air condition the billet press bays is 544 MBTU per year, which is equivalent to 14,022 BTU per warhead. This energy is not listed on the charts, but should be considered part of the process energy total because the cooling load imposed is from heated process equipment.

YEARLY STEAM CONSUMPTION FOR

M207E1, WARHEAD, GM, HE
I TOW

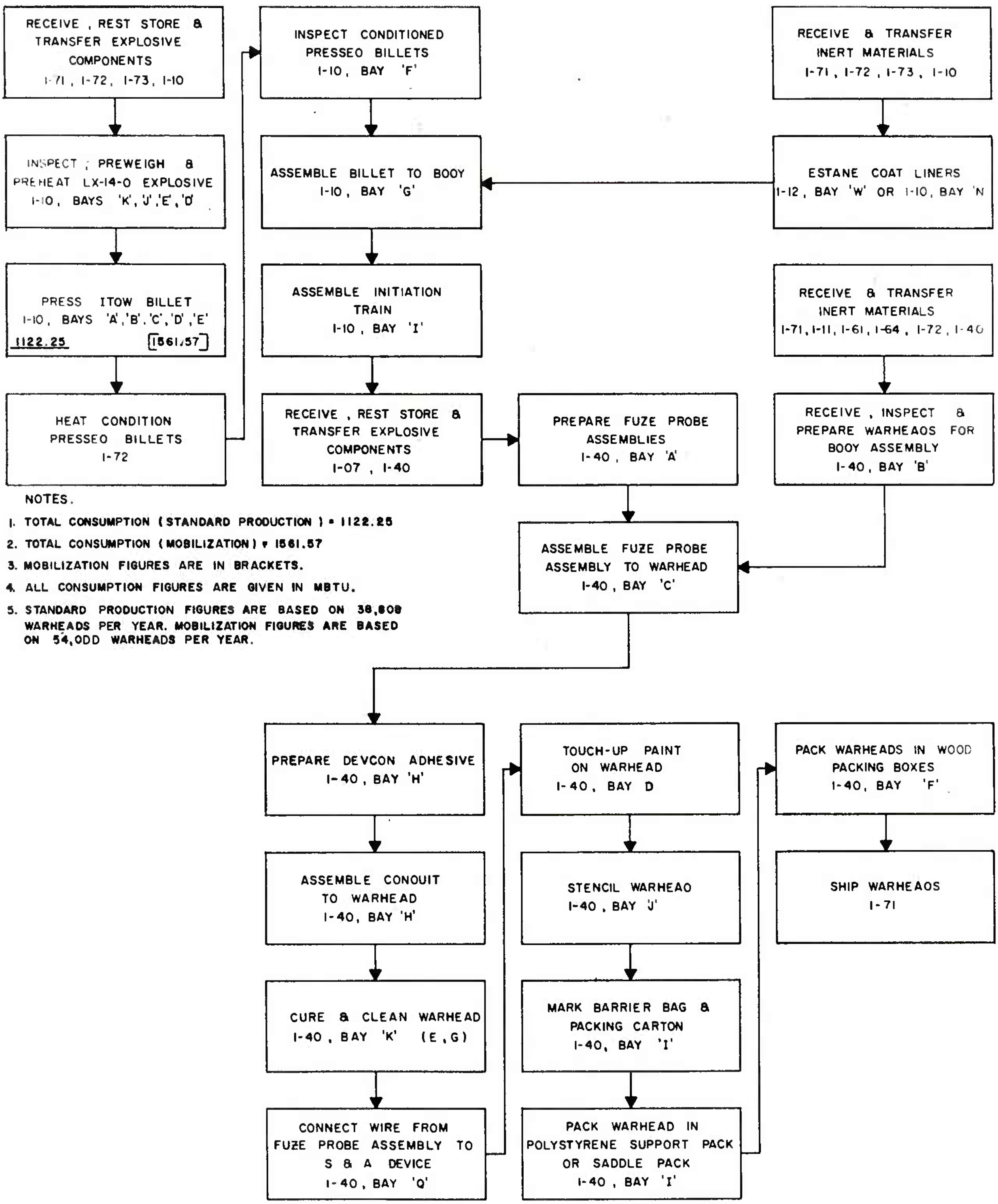


NOTE:

1. PROCESS STEAM IS NOT REQUIRED FOR PELLET PRESSING OPERATION.

YEARLY STEAM CONSUMPTION FOR

M207E1, WARHEAD, GM, HE ITOW



NOTES.

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 1122.25
2. TOTAL CONSUMPTION (MOBILIZATION) = 1561.57
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 38,808 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 54,000 WARHEADS PER YEAR.

YEARLY ELECTRICAL CONSUMPTION FOR

M207E1, WARHEAD, GM, HE
ITOW

RECEIVE & TRANSFER
PBXN-5 POWDER
6-92, BAY 'K' & LOADING DOCK

INSPECT PBXN-5 POWDER
6-1B-1

PREPARE PRESS FOR
MAKING PELLETS
6-49, BAY 'G'

RECEIVE & TRANSFER
INERT MATERIALS
6-92 DOCK, 6-49
28.24 [39.29]

PREWEIGH & PREHEAT
PBXN-5 POWDER
6-49, BAY 'E'
0.11 [0.15]

PRESS BOOSTER PELLET
M207E1
6-49
0.04 [0.06]

PRESS PIC M207E1
6-49, BAY 'D'

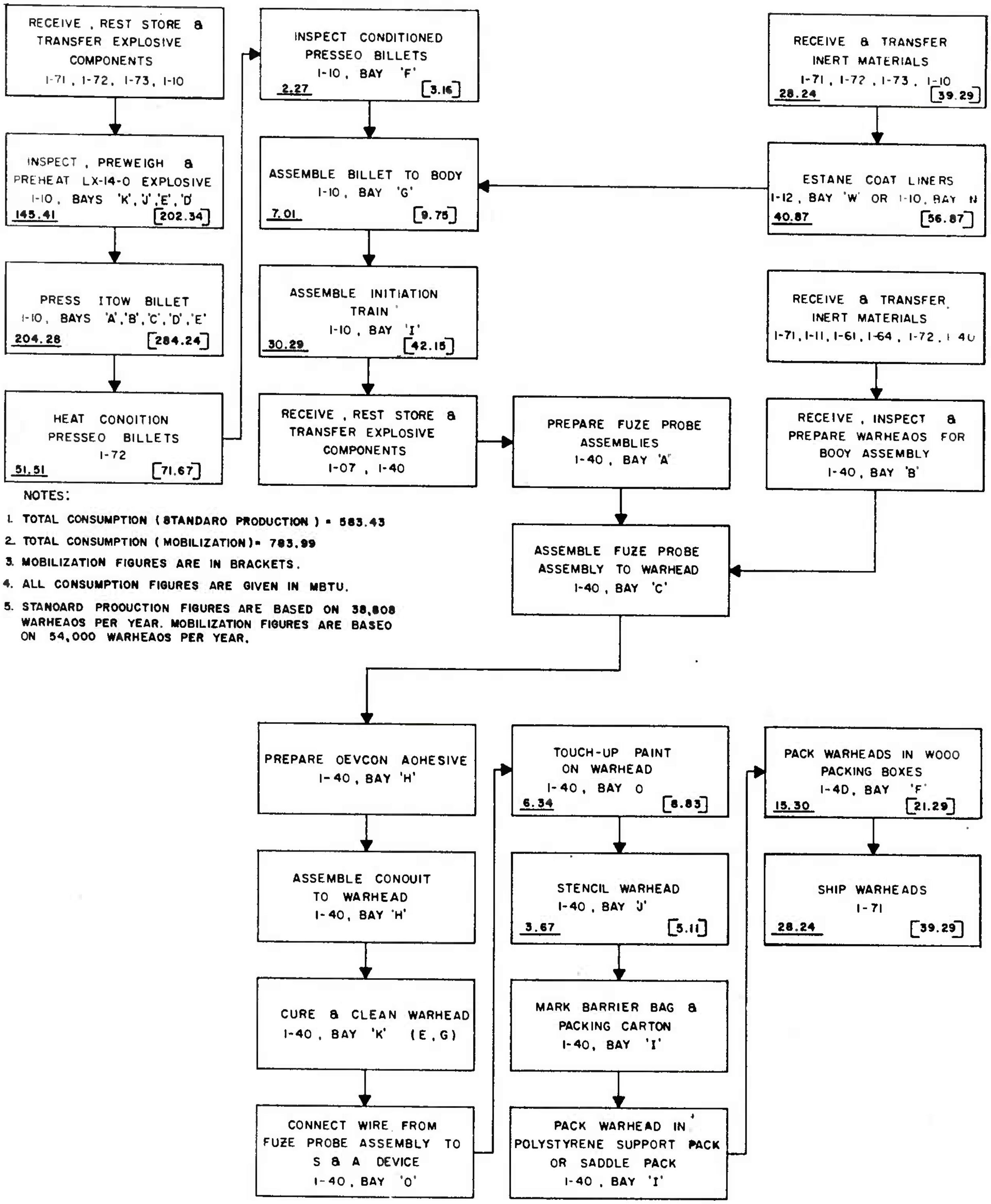
SHIP PELLETS & PIC'S
FROM LINE
6-92 LOADING DOCK

NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 28.39
2. TOTAL CONSUMPTION (MOBILIZATION) = 39.50
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 38,808 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 54,000 WARHEADS PER YEAR.

YEARLY ELECTRICAL CONSUMPTION FOR

M207E1, WARHEAD, GM, HE ITOW

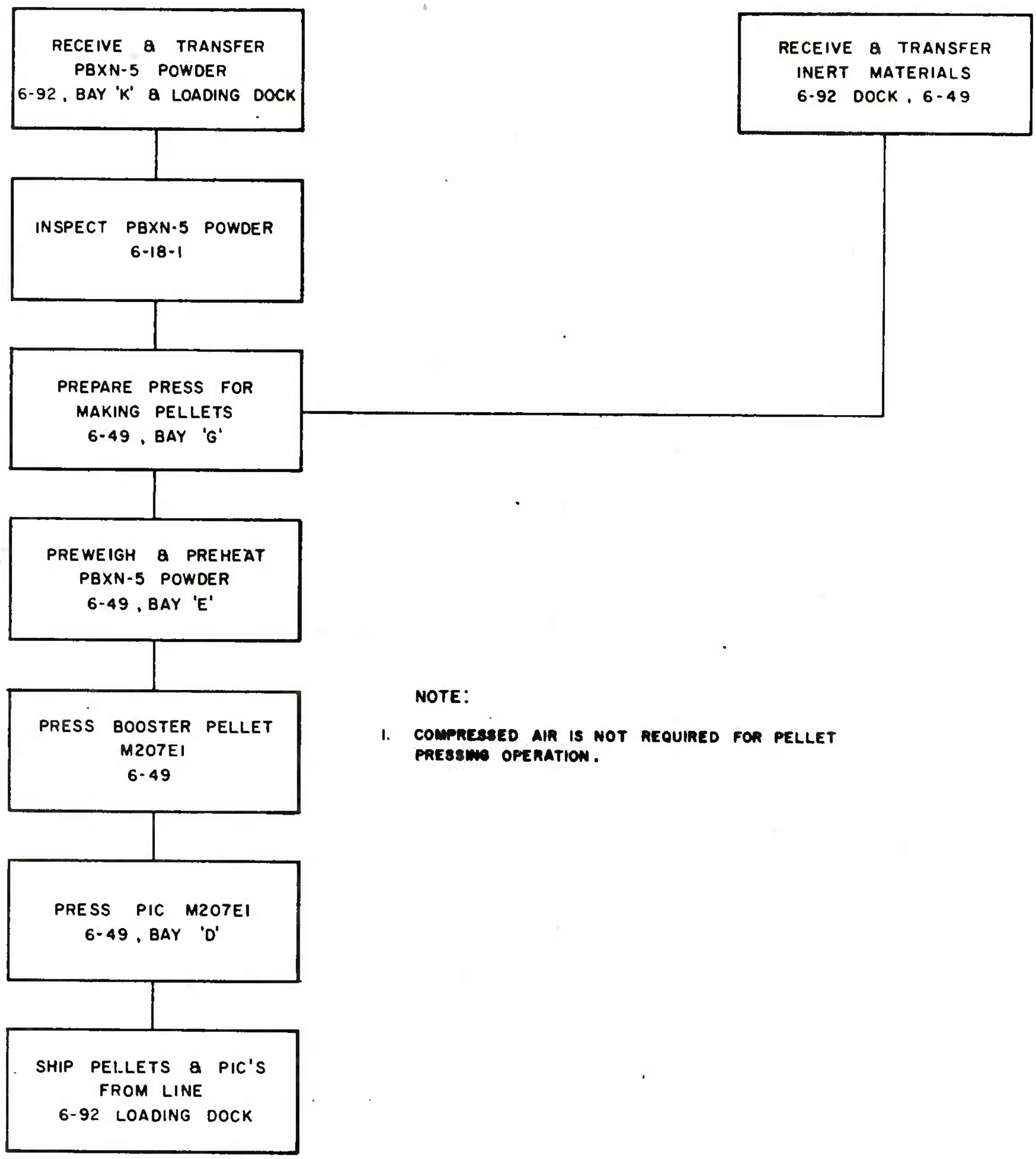


NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 583.43
2. TOTAL CONSUMPTION (MOBILIZATION) = 783.99
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 38,808 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 54,000 WARHEADS PER YEAR.

YEARLY AIR CONSUMPTION FOR

M207E1, WARHEAD, GM, HE
ITOW

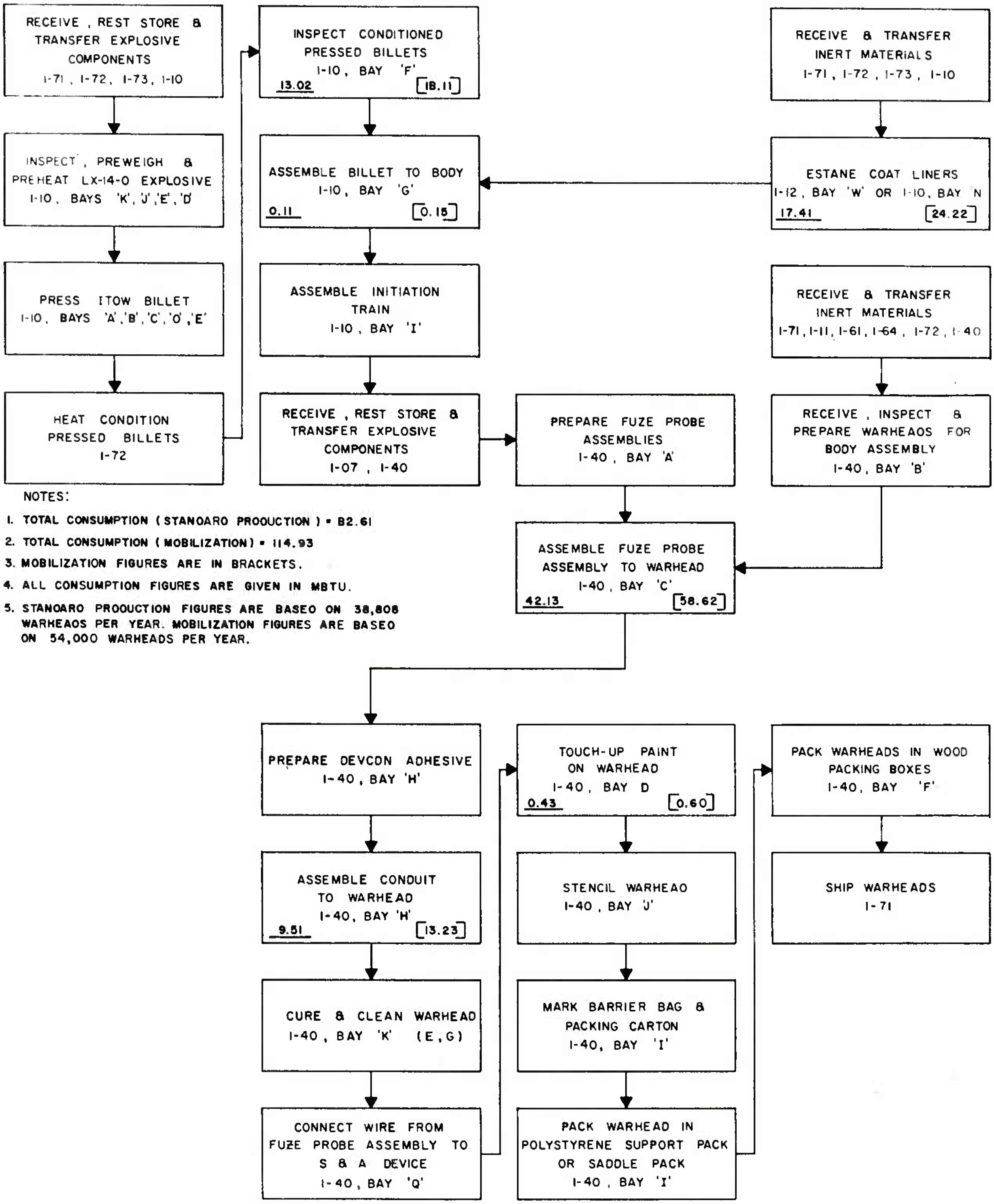


NOTE:

1. COMPRESSED AIR IS NOT REQUIRED FOR PELLET PRESSING OPERATION.

YEARLY AIR CONSUMPTION FOR

M207E1, WARHEAD, GM, HE ITOW



NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 82.61
2. TOTAL CONSUMPTION (MOBILIZATION) = 114.93
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 38,808 WARHEADS PER YEAR. MOBILIZATION FIGURES ARE BASED ON 54,000 WARHEADS PER YEAR.

M549A1, 155MM, HE, RA, PROJECTILE

PROCESS DESCRIPTION

The M549A1 is a rocket assisted projectile with a warhead containing approximately 18 pounds of TNT. A standard production rate of 99,036 projectiles per year was used in this report. The mobilization production rate, according to the latest IAAP mobilization schedule, is 585,600 projectiles per year.

Inert materials are received at load line storage buildings. Warheads are unpacked, prepared for loading, and transferred to the melt building as needed. Explosive materials are received at a service magazine and transferred to the melt building for processing as needed.

TNT is melted in a grid melt unit and mixed with TNT feather in a melt kettle, at a temperature of 190°F. Approximately 18 pounds of TNT are poured into the warheads, which are then loaded into the curing oven. After curing, the warheads are probed with a hot probe to remove cavities formed in the casting, and allowed to cool for ten minutes. Molten TNT is then added and the warheads are allowed to cool for a minimum of ten hours. The riser is then removed, and the warheads are probed again. This is followed by a second add pour. After the second add pour, the warheads are allowed to cool for a minimum of two hours, then are transferred to rest store. The warheads are cleaned and drilled, liners are inserted, and they are then x-rayed to check for defects. Accepted warheads are palletized and shipped intraplant to the post cyclic heating area, where they are maintained at 135 - 150°F for 12 - 18 hours, allowed to cool to no less than 70°F for 12 hours, and reheated to 135 - 150°F for 12 - 18 hours. After cooling, accepted warheads are shipped to the final assembly area.

The rocket motor bodies are assembled and attached to warheads. The projectiles are x-rayed, supplementary charges inserted, and the projectiles are weighed and stenciled. Accepted projectiles are then palletized and shipped out.

This process description was extracted from the following IAAP Standing Operating Procedures:

S.O.P No. 765 - TNT Load Warhead for Projectile, 155MM, HE, RA, M549A1

S.O.P. No. 699 - Assemble and Pack Projectile 155MM, HE, RA, M549 and M549A1

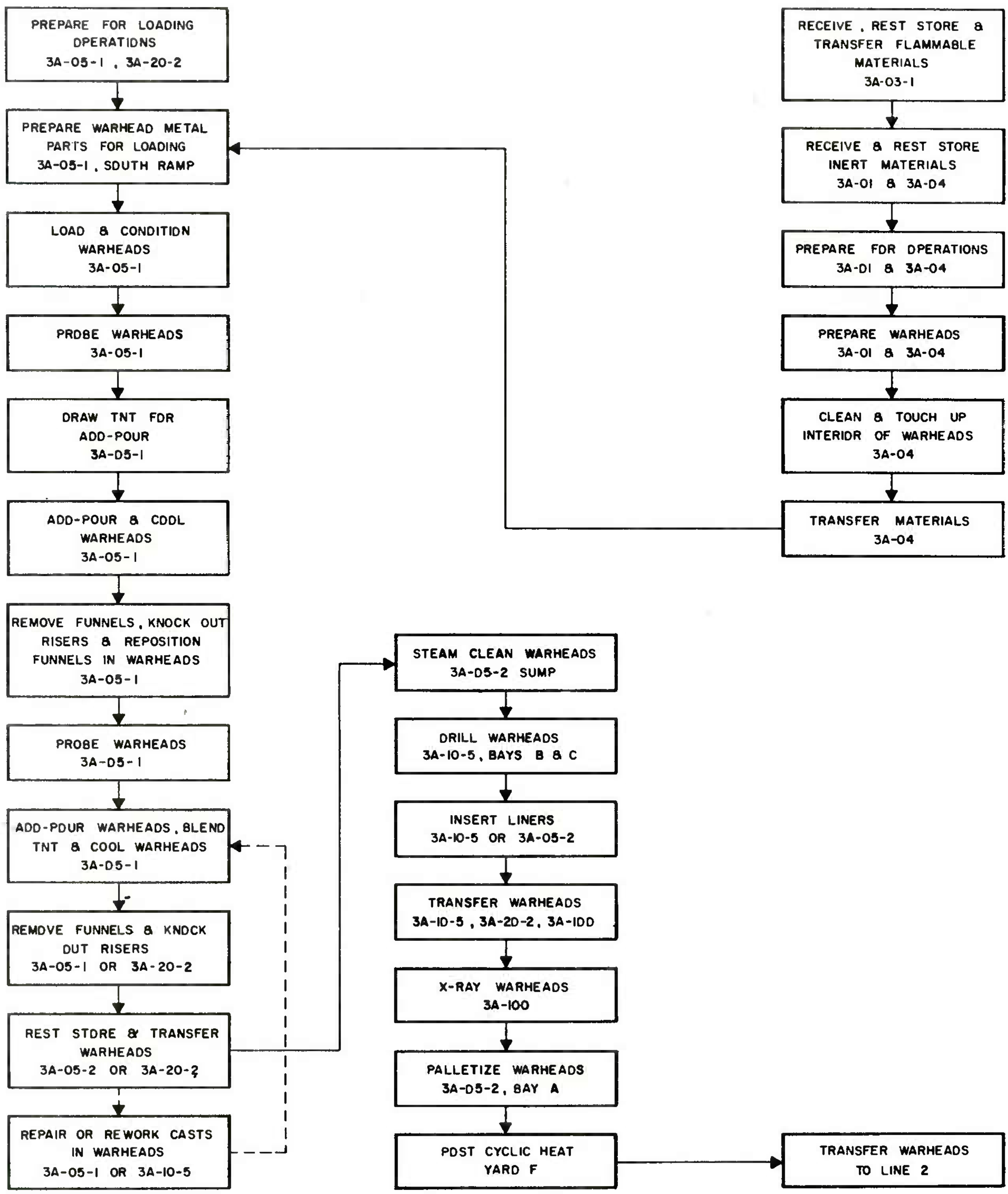
S.O.P. No. 764 - Line 3A Service Magazines, Screening Building and Second and Third Floor Melt Tower Operations.

S.O.P. No. 704 - Post Cyclic Heat, Projectiles and/or Warheads, Yard F

PROCESS FLOW FOR

M549 / M549A1 , PROJECTILE

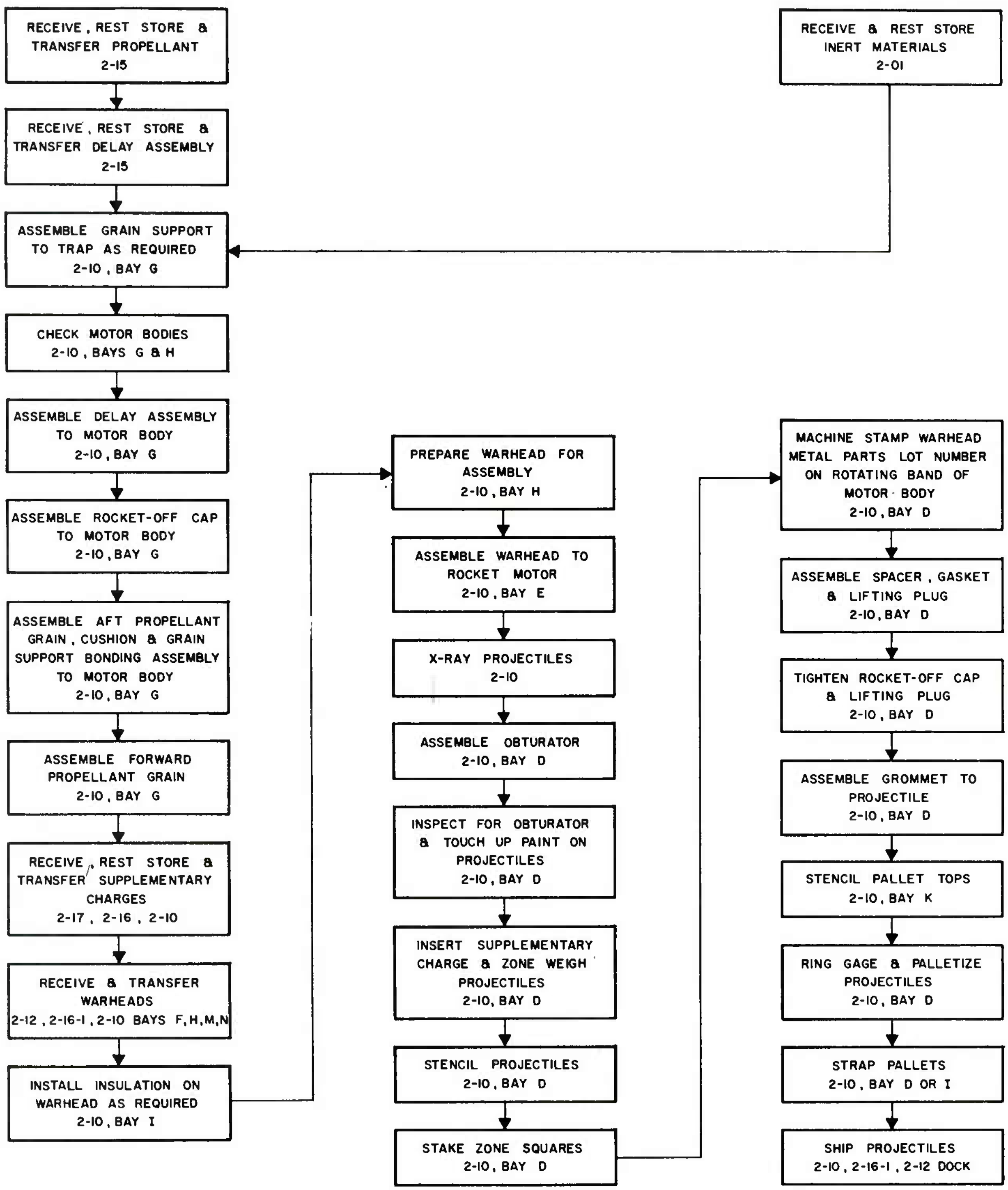
(LINE 3A POUR)



PROCESS FLOW FOR

M549 / M549A1 , PROJECTILE

(LINE 2 ASSEMBLY)



Energy Consumption

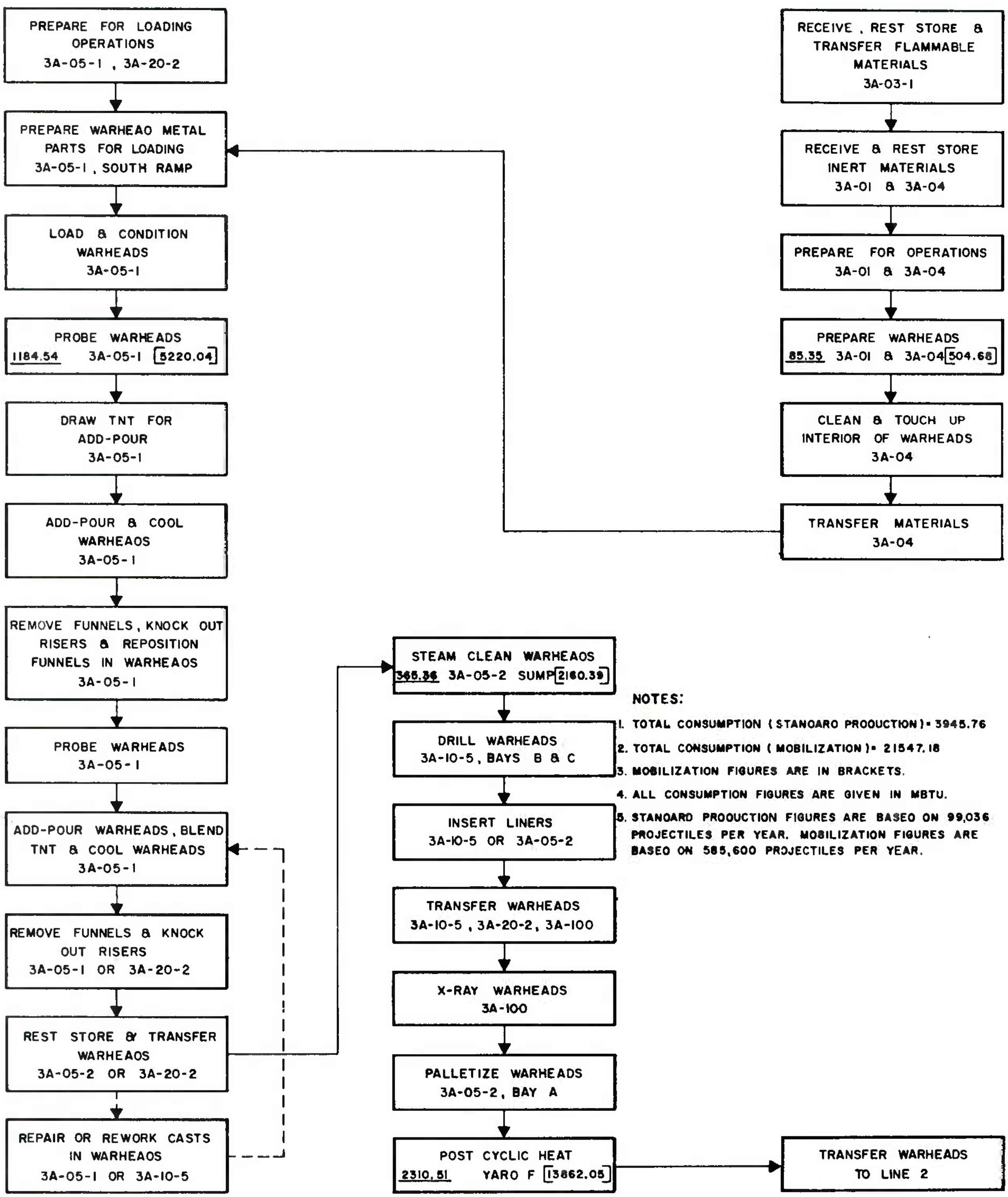
The process energy consumed in the production of the M549A1, HE, Projectile totaled 5,107 MBTU per year at a production rate of 99,026 projectiles per year as produced at the Iowa Army Ammunition Plant. This amounts to 51,572 BTU per projectile. Planned mobilization production of 585,600 projectiles per year would consume 29,417 MBTU per year.

The following charts show a breakdown of energy consumption by production step and form of energy.

YEARLY STEAM CONSUMPTION FOR

M549 / M549A1 , PROJECTILE

(LINE 3A POUR)



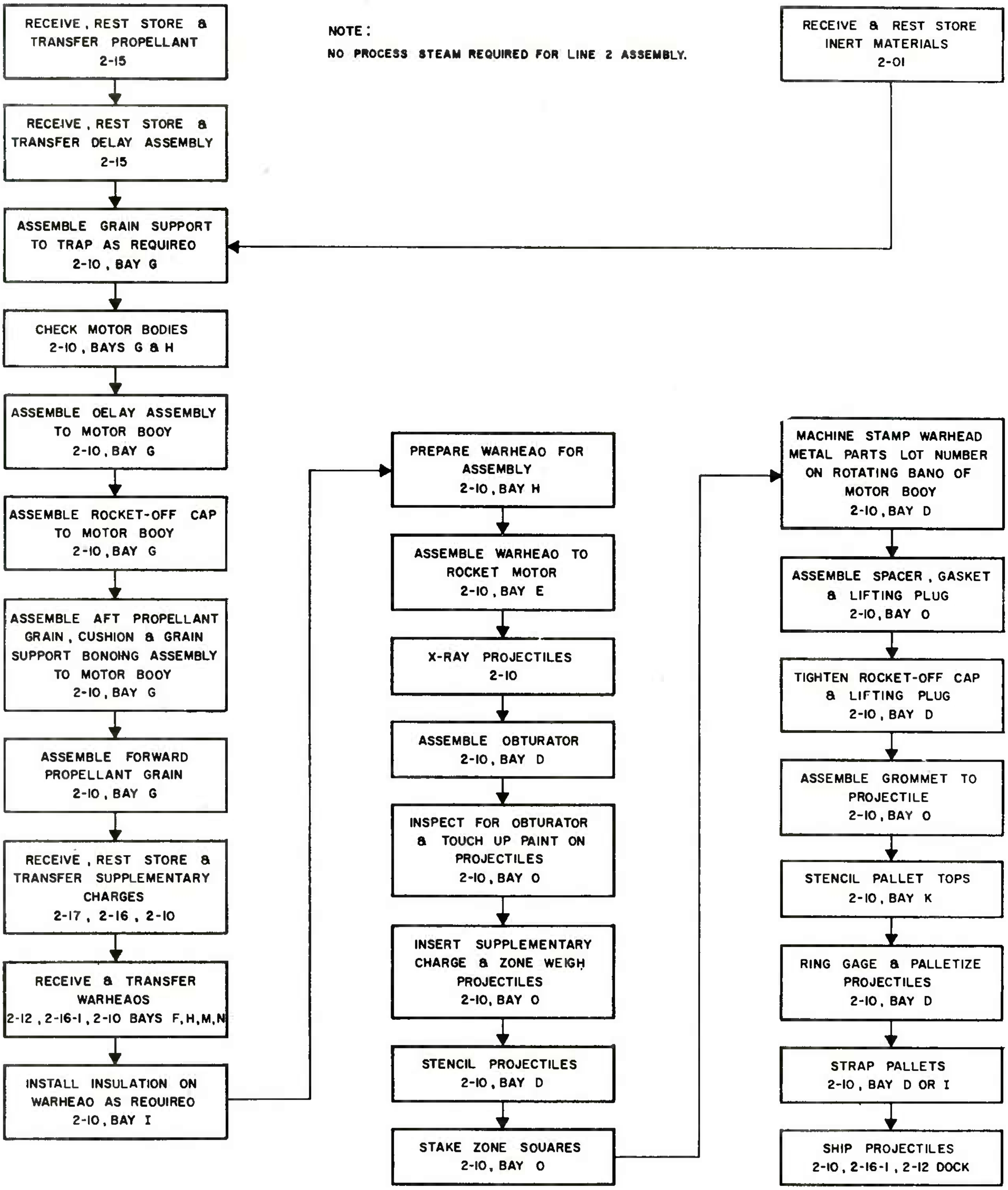
NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 3945.76
2. TOTAL CONSUMPTION (MOBILIZATION) = 21547.18
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 99,036 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 585,600 PROJECTILES PER YEAR.

YEARLY STEAM CONSUMPTION FOR

M549 / M549A1 , PROJECTILE

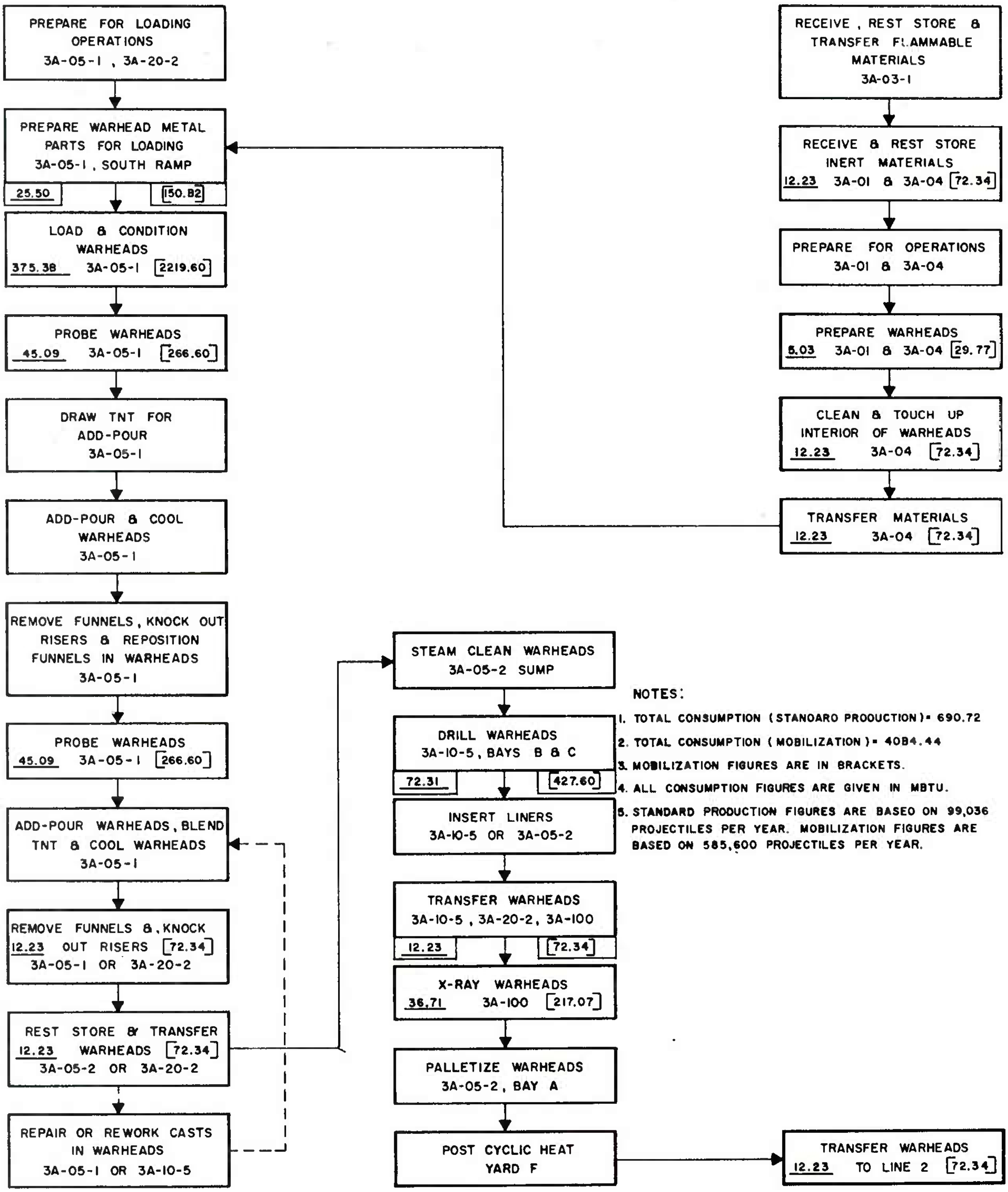
(LINE 2 ASSEMBLY)



YEARLY ELECTRICAL CONSUMPTION FOR

M549 / M549A1 , PROJECTILE

(LINE 3A POUR)



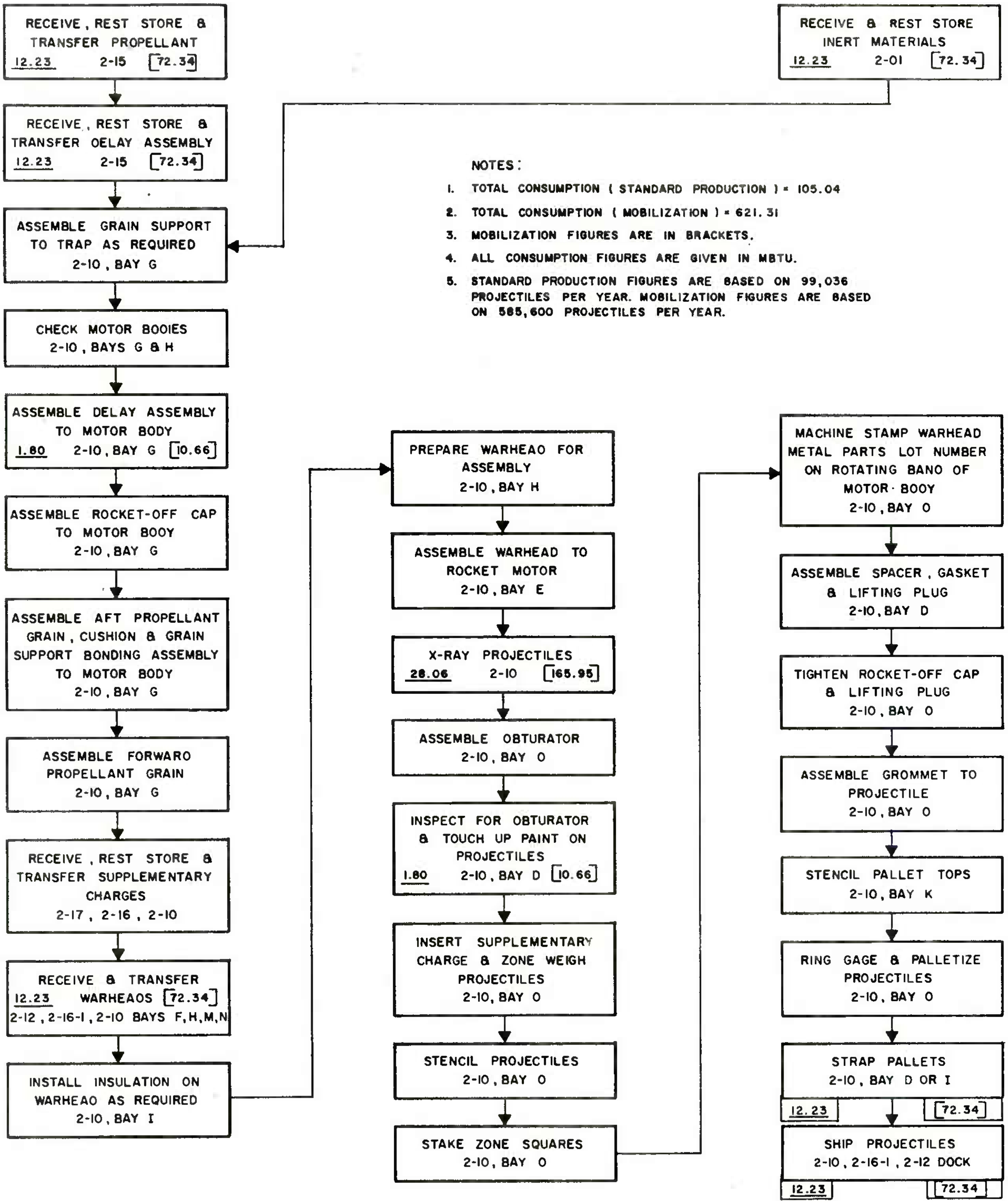
NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 690.72
2. TOTAL CONSUMPTION (MOBILIZATION) = 4084.44
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 99,036 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 585,600 PROJECTILES PER YEAR.

YEARLY ELECTRICAL CONSUMPTION FOR

M549 / M549A1, PROJECTILE

(LINE 2 ASSEMBLY)



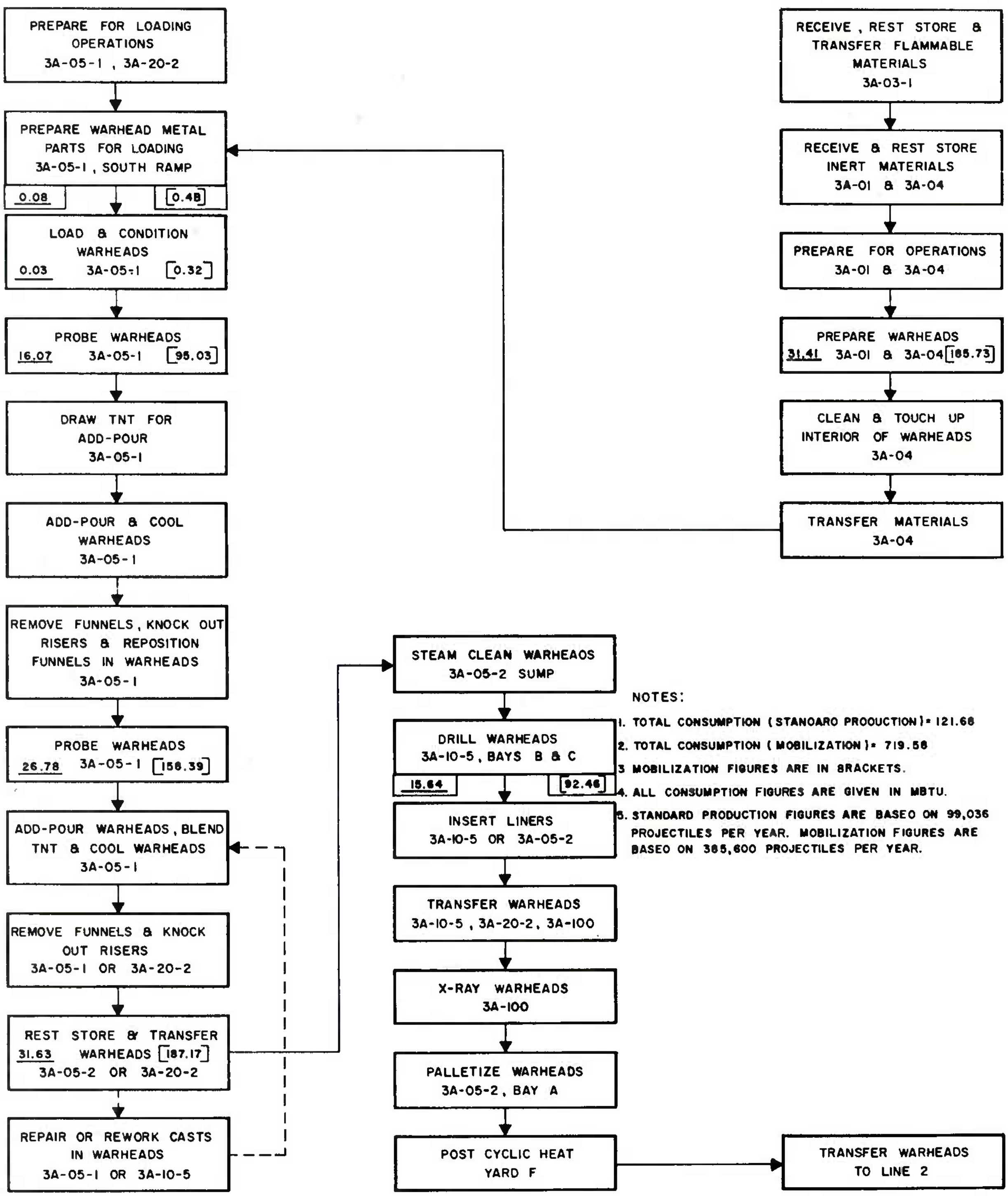
NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 105.04
2. TOTAL CONSUMPTION (MOBILIZATION) = 621.31
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 99,036 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 585,600 PROJECTILES PER YEAR.

YEARLY AIR CONSUMPTION FOR

M549 / M549A1, PROJECTILE

(LINE 3A POUR)



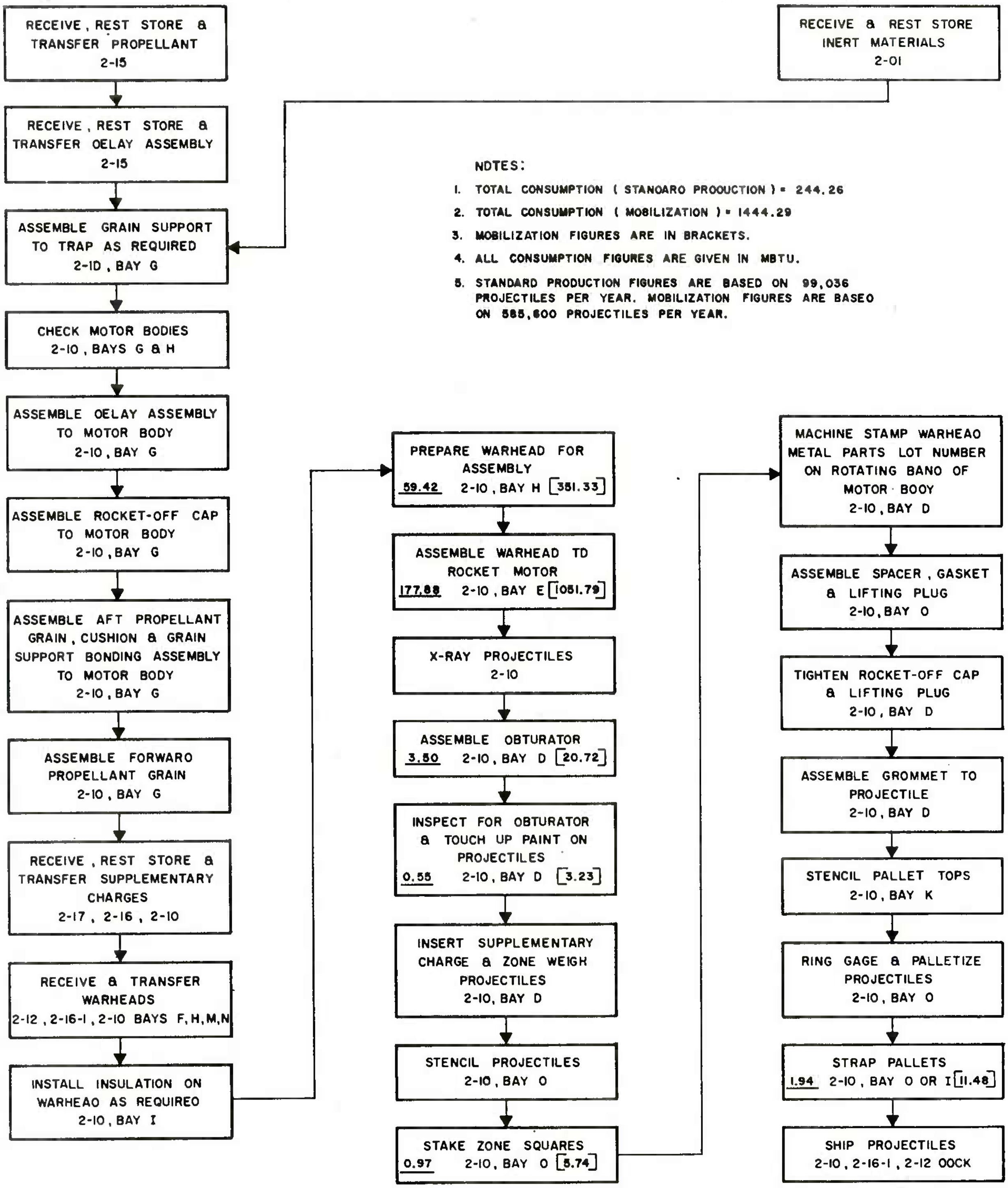
NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 121.68
2. TOTAL CONSUMPTION (MOBILIZATION) = 719.58
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 99,036 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 365,600 PROJECTILES PER YEAR.

YEARLY AIR CONSUMPTION FOR

M549 / M549A1, PROJECTILE

(LINE 2 ASSEMBLY)



NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 244.26
2. TOTAL CONSUMPTION (MOBILIZATION) = 1444.29
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 99,036 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 585,600 PROJECTILES PER YEAR.

M718/M741, 155MM, AT, PROJECTILE

PROCESS DESCRIPTION

The M718/M741 is a projectile containing 9 mines, each mine containing approximately 1.3 pounds of PBX explosive. A standard production rate of 36,792 projectiles per year was used in this report. The mobilization production rate, according to the latest IAAP mobilization schedule, is 60,000 projectiles per year.

Explosive materials are received at load line service magazines and transferred to pressing areas as required. Inert materials are received and transferred to assembly area as required for production.

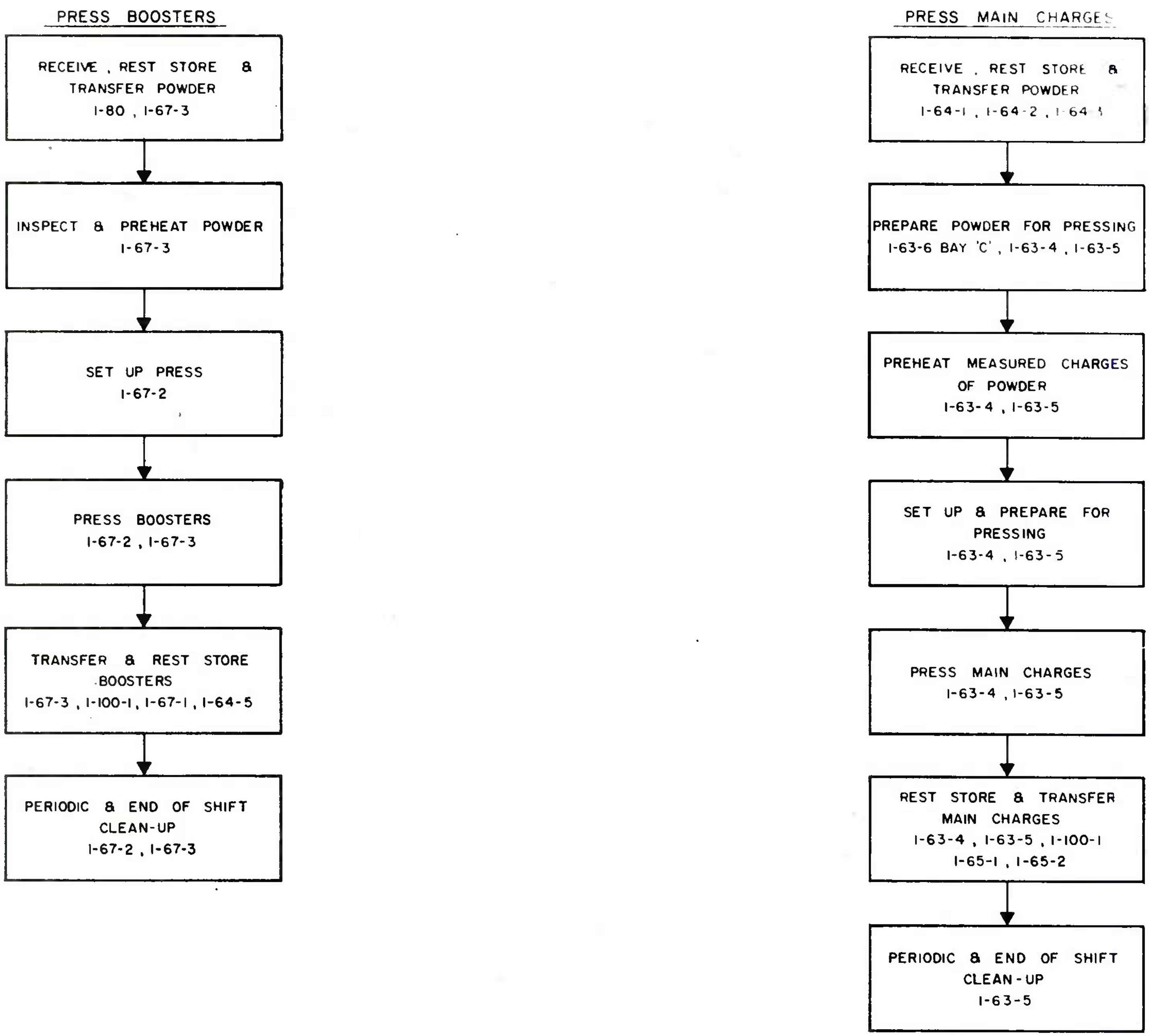
PBX is processed as required for pressing boosters and main charges. Powder for main charges is preheated to a temperature of 200°F; press tooling is heated by steam to a minimum temperature of 175°F. After pressing, boosters and main charges are inspected and transferred to rest store until needed for mine assembly.

Mine electronic components are assembled and inspected, then are transferred to mine assembly area. Mine bodies are assembled, with boosters and main charges, and are cleaned and painted. Mines are cured in a steam heated curing oven for a minimum of 16 hours at a temperature of 125°F. Painted mines are rest stored and then transferred to final assembly building, where they are loaded into projectile bodies, stenciled, packed and shipped out.

This process description was extracted from IAAP Standing Operating Procedure No. 812, Press Boosters and Main Charges for Projectile, 155MM, AT, M718/M741 and Standing Operating Procedure No. 715, Load, Assemble and Pack Projectile, 155MM, AT, M718/M741.

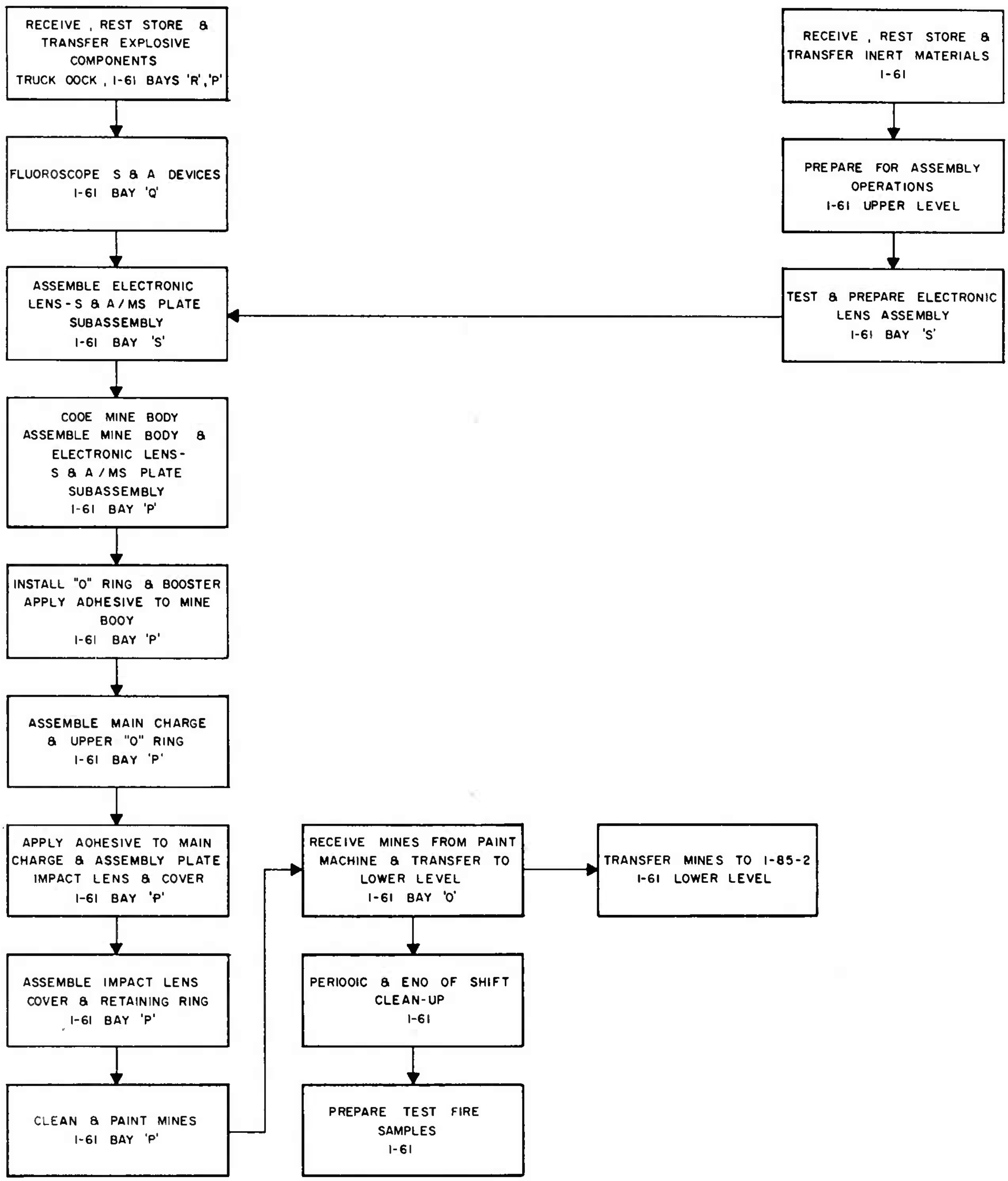
PROCESS FLOW FOR

M718 / M741, PROJECTILE PRESS CHARGES



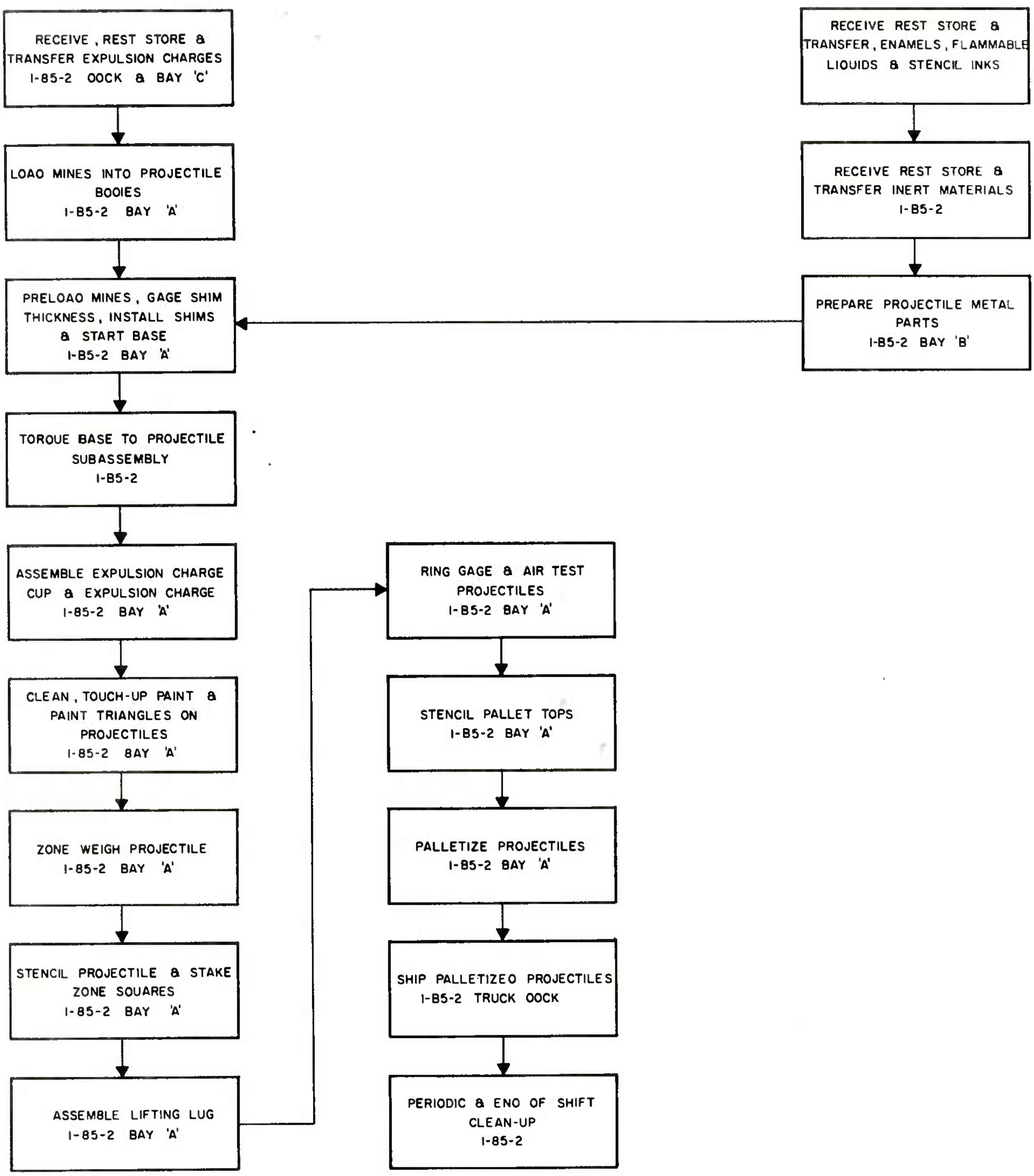
PROCESS FLOW FOR

M718 / M741, PROJECTILE MINE ASSEMBLY



PROCESS FLOW FOR

M718 / M741 , PROJECTILE FINAL ASSEMBLY



Energy Consumption

The process energy consumed in the production of the M718/M741 Projectile totaled 2,895 MBTU per year at a production rate of 36,792 projectiles per year as produced at the Iowa Army Ammunition Plant. This is equivalent to 78,694 BTU per projectile. Planned mobilization production of 60,000 projectiles per year would consume 4,722 MBTU per year.

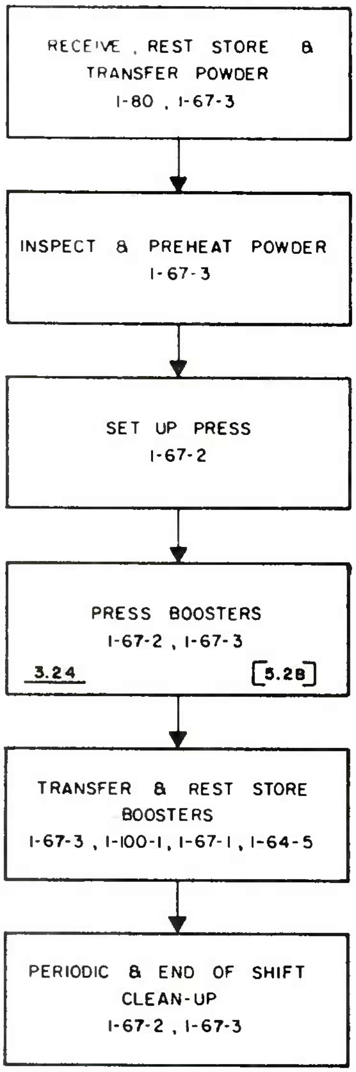
The following charts show a breakdown of energy consumption by production step and form of energy.

The energy required to air condition the main charge pressing areas amounted to 1,855 MBTU per year, which is equivalent to 50,416 BTU per projectile. This energy is not listed on the charts, but should be considered part of the process energy because the cooling load is from heated process equipment.

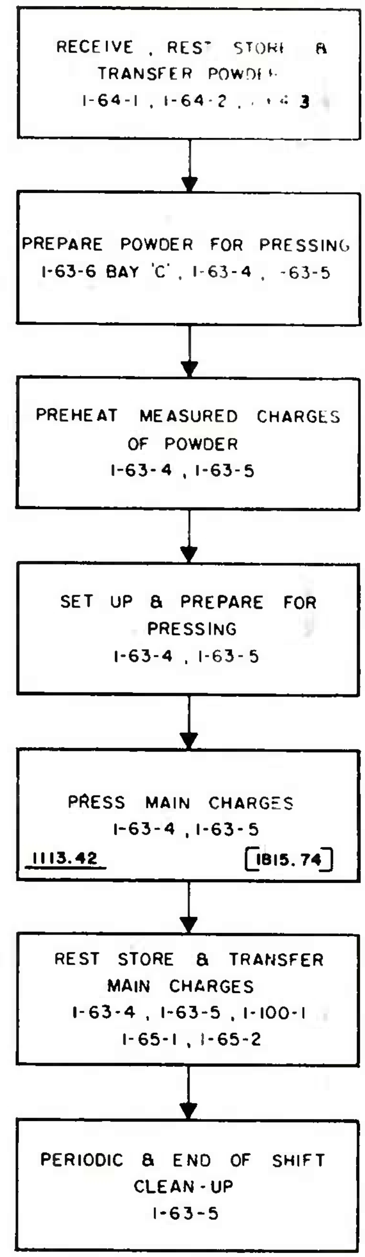
YEARLY STEAM CONSUMPTION FOR

M718 / M741 , PROJECTILE PRESS CHARGES

PRESS BOOSTERS



PRESS MAIN CHARGES

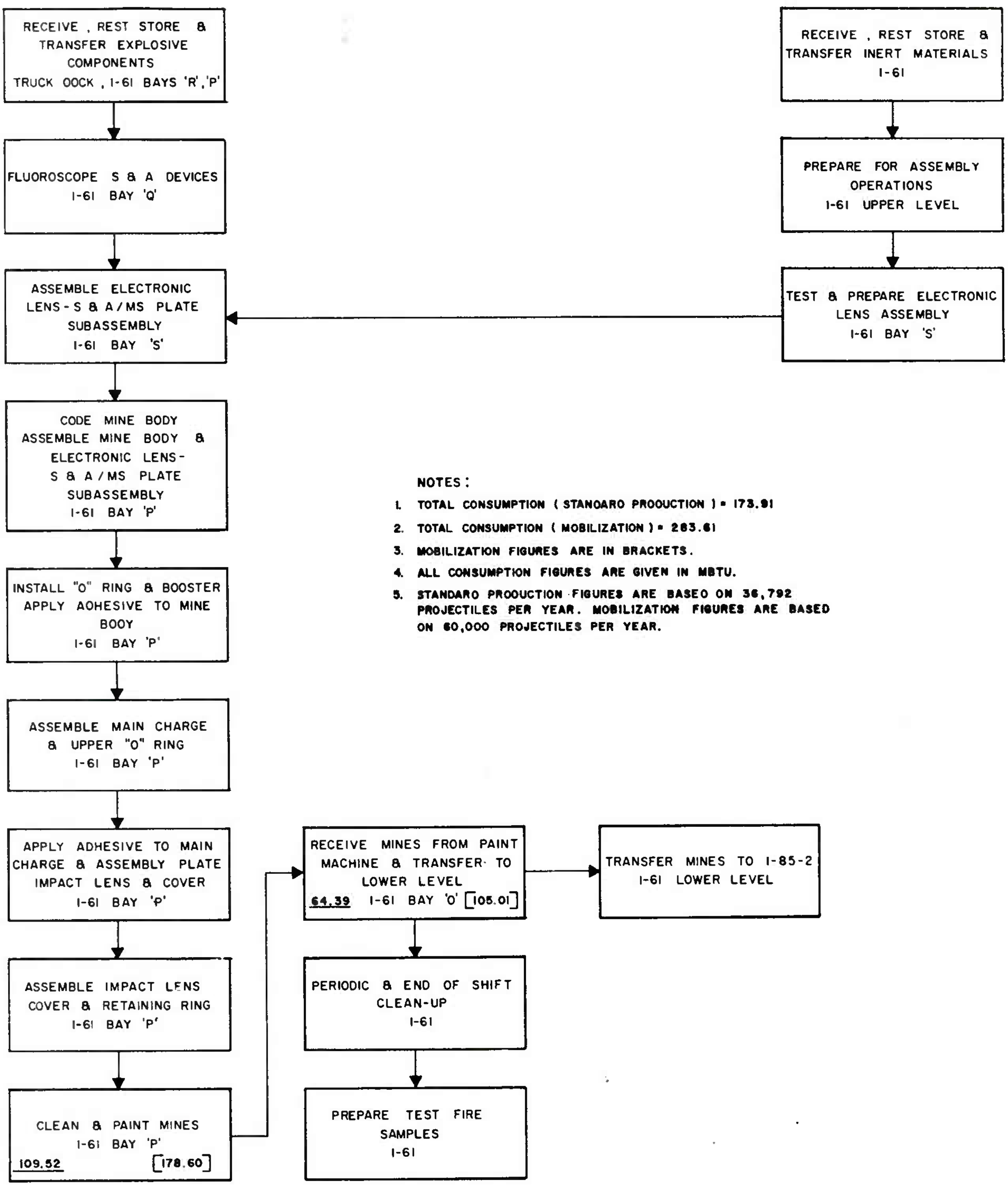


NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 1116.66
2. TOTAL CONSUMPTION (MOBILIZATION) = 1821.02
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 36,792 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 60,000 PROJECTILES PER YEAR.

YEARLY STEAM CONSUMPTION FOR

M718 / M741, PROJECTILE MINE ASSEMBLY



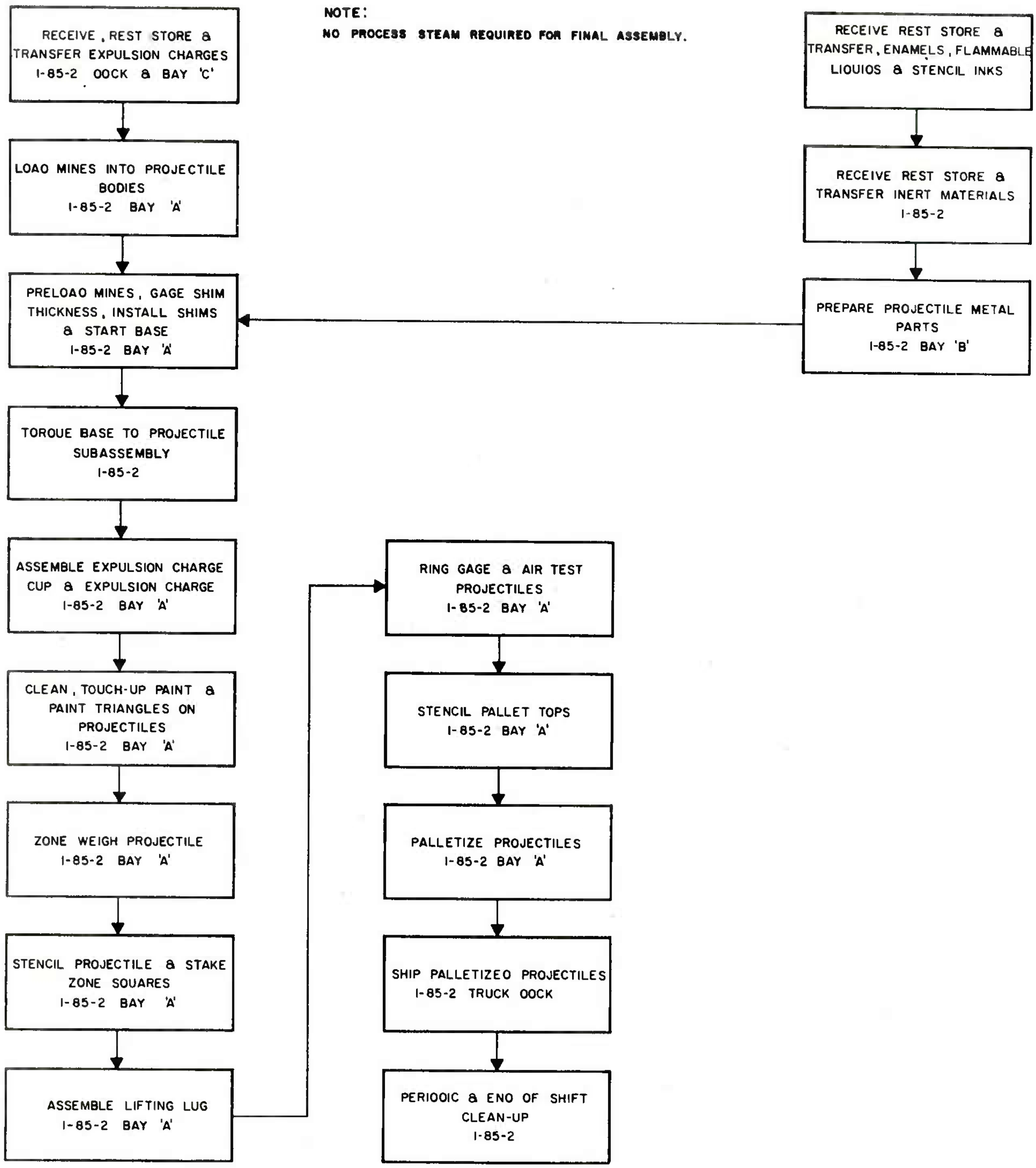
NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 173.91
2. TOTAL CONSUMPTION (MOBILIZATION) = 283.61
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 36,792 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 60,000 PROJECTILES PER YEAR.

YEARLY STEAM CONSUMPTION FOR

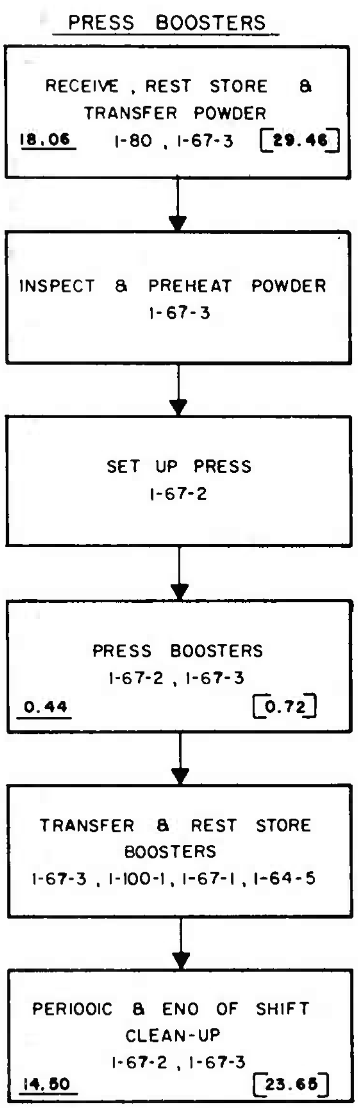
M718 / M741 , PROJECTILE FINAL ASSEMBLY

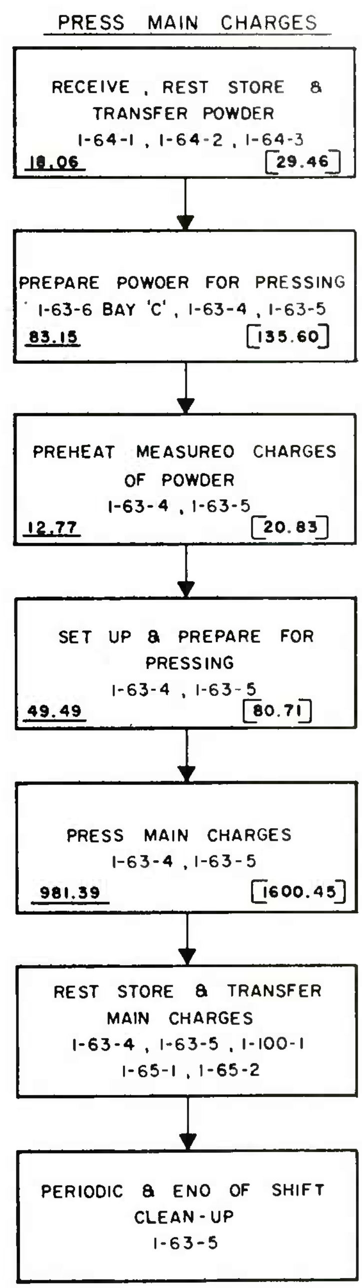
NOTE:
NO PROCESS STEAM REQUIRED FOR FINAL ASSEMBLY.



YEARLY ELECTRICAL CONSUMPTION FOR

M718 / M741 , PROJECTILE PRESS CHARGES



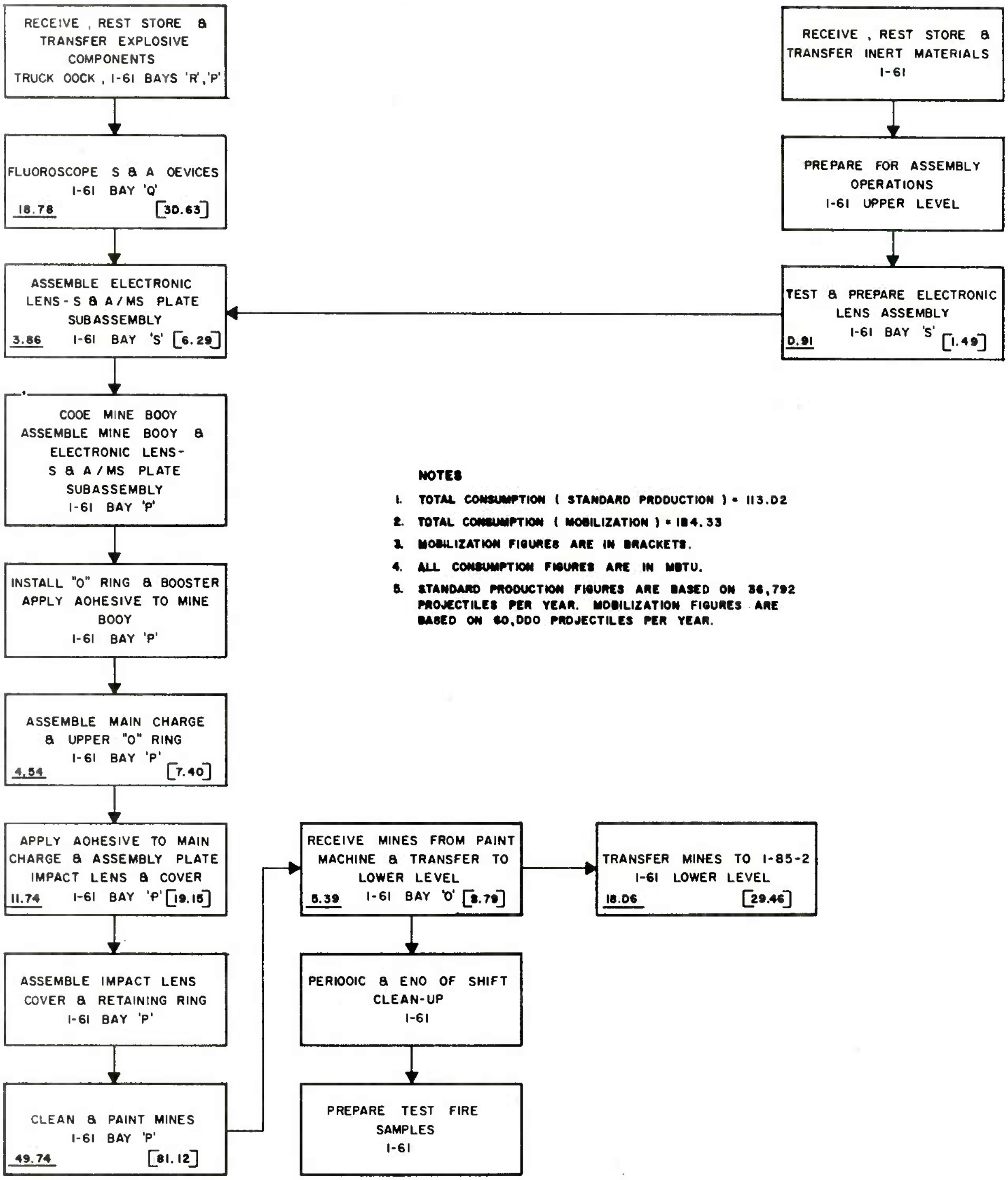


NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 1177.86
2. TOTAL CONSUMPTION (MOBILIZATION) = 1920.88
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 36,792 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 60,000 PROJECTILES PER YEAR.

YEARLY ELECTRICAL CONSUMPTION FOR

M718 / M741, PROJECTILE MINE ASSEMBLY



NOTES

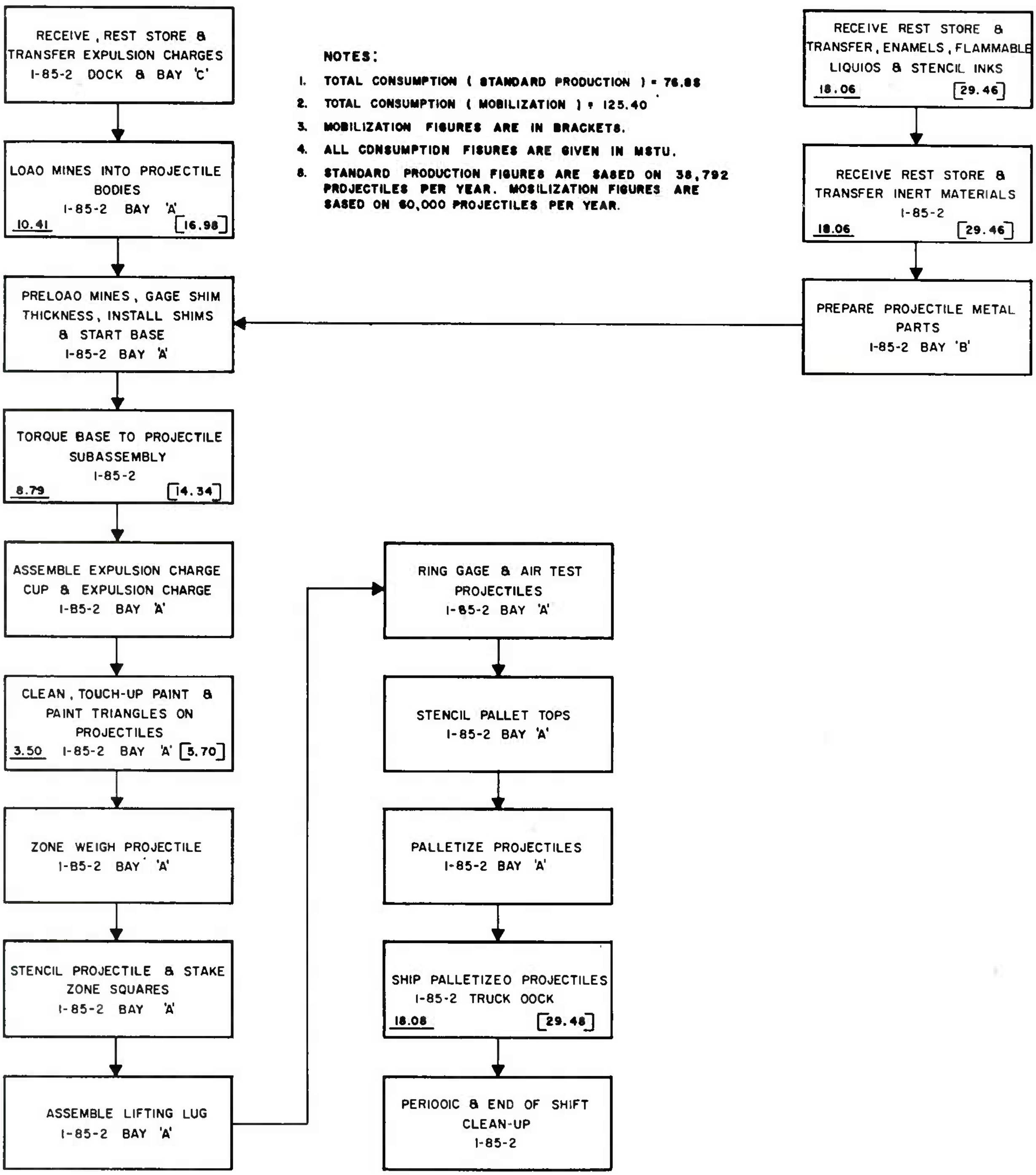
1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 113.02
2. TOTAL CONSUMPTION (MOBILIZATION) = 184.33
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 36,792 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 60,000 PROJECTILES PER YEAR.

YEARLY ELECTRICAL CONSUMPTION FOR

M718 / M741, PROJECTILE FINAL ASSEMBLY

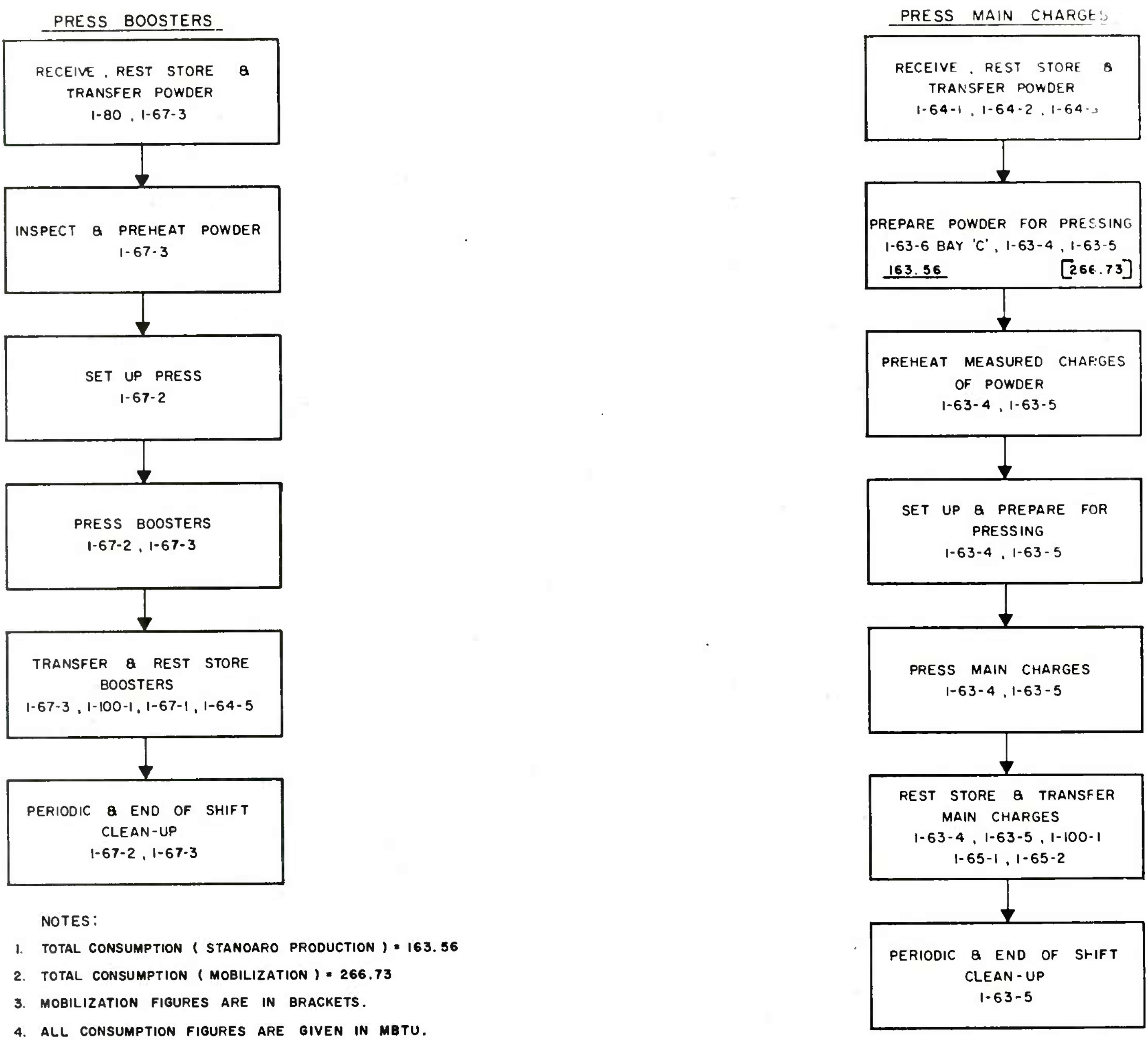
NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 76.88
2. TOTAL CONSUMPTION (MOBILIZATION) = 125.40
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 38,792 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 60,000 PROJECTILES PER YEAR.



YEARLY AIR CONSUMPTION FOR

M718 / M741, PROJECTILE PRESS CHARGES

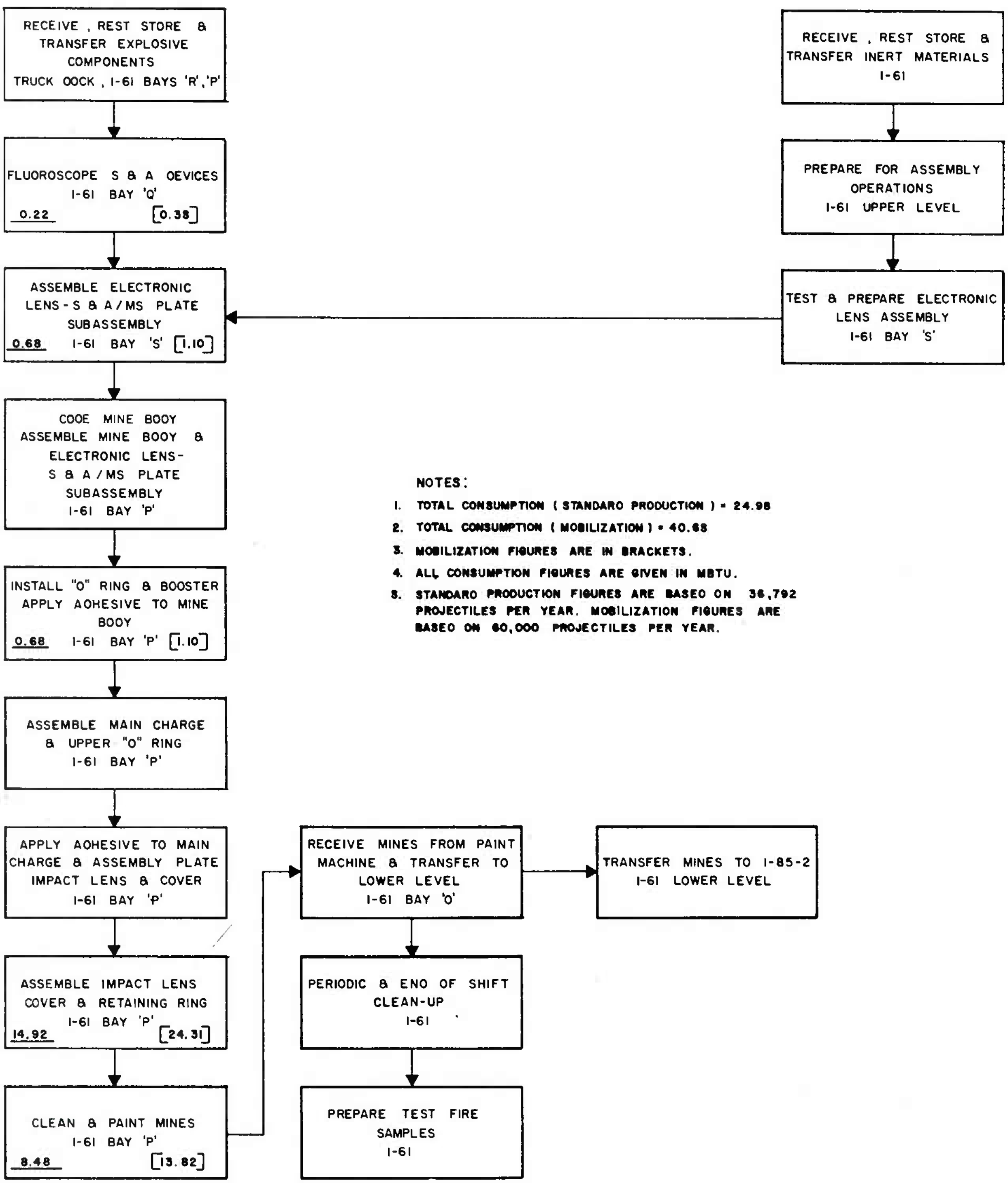


NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 163.56
2. TOTAL CONSUMPTION (MOBILIZATION) = 266.73
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 36,792 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 60,000 PROJECTILES PER YEAR.

YEARLY AIR CONSUMPTION FOR

M718 / M741, PROJECTILE MINE ASSEMBLY



NOTES:

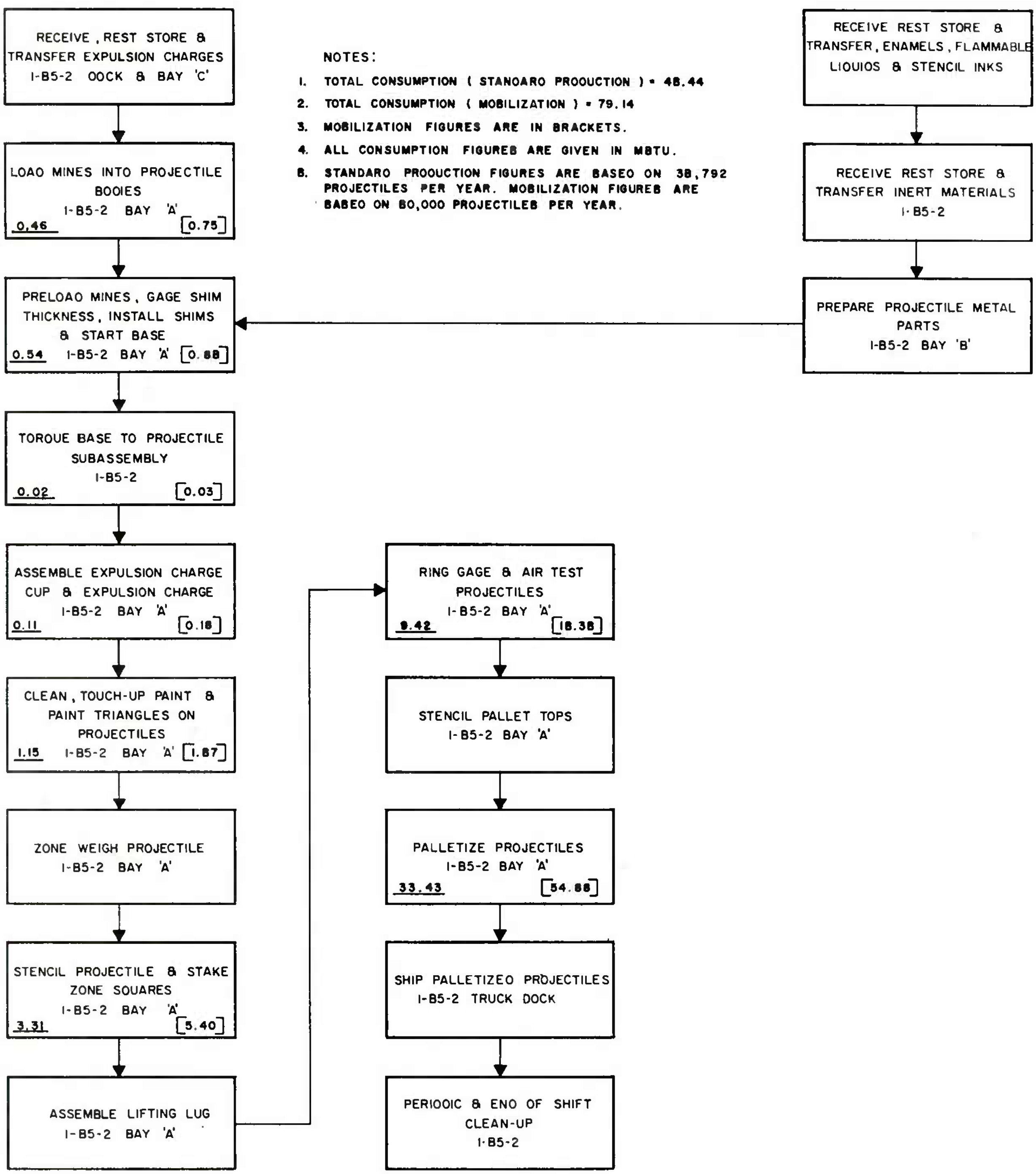
1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 24.98
2. TOTAL CONSUMPTION (MOBILIZATION) = 40.68
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 36,792 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 60,000 PROJECTILES PER YEAR.

YEARLY AIR CONSUMPTION FOR

M718 / M741, PROJECTILE FINAL ASSEMBLY

NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 48.44
2. TOTAL CONSUMPTION (MOBILIZATION) = 79.14
3. MOBILIZATION FIGURES ARE IN BRACKETS.
4. ALL CONSUMPTION FIGURES ARE GIVEN IN MBTU.
5. STANDARD PRODUCTION FIGURES ARE BASED ON 38,792 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 60,000 PROJECTILES PER YEAR.



CONSERVATION PROJECTS

INSULATE HAWK BATH AND SUPPLY TANK

Both the hot water supply tank and the HAWK bath for conditioning the HAWK Warhead are uninsulated, allowing excessive heat loss. An analysis was undertaken to determine the economic feasibility of insulation.

INSULATE PROCESS TANK

Existing Conditions:

Inside temperature (T1) = 190°F

Outside temperature (T2) = 70°F

Surface area (A) = 166 Ft^2

Bare metal heat loss (q) = 150 BTU/hr-ft^2

Operating time = 17 hr/day

= 3 days/week

= 50 weeks/year

Present heat loss:

$Q = A \times q \times 17 \times 3 \times 50 \div 10^6$

$= 166 \times 150 \times 17 \times 3 \times 50 \div 10^6 = 63.5$ MBTU/year

Proposed - add 1½" calcium silicate, U = .25 BTU/hr - Ft^2 -°F

$Q = A \times U \times (T_1 - T_2) \times 15 \times 3 \times 50 \div 10^6$

$= 166 \times .25 \times (190 - 70) \times 17 \times 3 \times 50 \div 10^6 = 12.7$ MBTU/year

Net savings:

63.5 - 12.7 = 50.8 MBTU/year

Gross Savings (heating system efficiency = 80%) - 63.5 MBTU/year

INSULATE HAWK BATH

Existing conditions:

Lid	78 ft^2	300°F	9 hours	300 BTU/hr-ft^2
Tank	650 ft^2	190°F	9 hours	150 BTU/hr-ft^2
Tank	728 ft^2	130°F	8 hours	100 BTU/hr-ft^2

Present heat loss:

Lid - $78 \times 300 \times 9 \times 3 \times 50 \div 10^6 = 31.6$ MBTU/year

Tank - $650 \times 150 \times 9 \times 3 \times 50 \div 10^6 = 131.6$ MBTU/year

Tank - $728 \times 100 \times 8 \times 3 \times 50 \div 10^6 = 87.4$ MBTU/year

Total $= 250.6$ MBTU/year

Proposed - add 1½" calcium silicate, $U = 0.25$ BTU/hr-ft^2-°F

Lid - $78 \times .25 \times (300 - 70) \times 9 \times 3 \times 50 \div 10^6 = 6.1$ MBTU/year

Tank - $650 \times .25 \times (190 - 70) \times 9 \times 3 \times 50 \div 10^6 = 26.3$ MBTU/year

Tank - $728 \times .25 \times (130 - 70) \times 8 \times 3 \times 50 \div 10^6 = 13.1$ MBTU/year

Total $= 45.5$ MBTU/year

Net savings - $250.6 - 45.5 = 205.1$ MBTU/year

Gross Savings - 256.4 MBTU/year

The HAWK conditioning insulation project would provide a total of 319.9 MBTU per year in steam savings. At a present cost of approximately $5/MBTU, the cost savings would be $1,600 per year. Material and installation costs would be approximately $7,500. This would provide a payback of 4.7 years.

INSULATE KETTLES AND PROCESS PIPING

Presently, the melt kettles and process piping for the three melt buildings surveyed in this phase of the project are uninsulated. An economic analysis was undertaken to determine the feasibility of adding 1.5" of calcium silicate insulation. The following calculations are for one melt building.

PROCESS PIPING

1500 lineal feet - 2" pipe

80 BTU/hr-LF heat loss - uninsulated

27 BTU/hr-LF heat loss - insulated

2080 hours per year

Savings - $(80 - 27) \times 1500 \times 2080 \div 10^6 = 165$ MBTU/year

KETTLES

400 ft^2

150 BTU/ft^2 hr - uninsulated

25 BTU/ft^2 hr - insulated

2080 hours per year

Savings - $(150 - 25) \times 400 \times 2080 \div 10^6 = 104$ MBTU/year

Total Savings - 165 + 104 = 269 MBTU/year

Due to irregular shapes and the need for waterproof covers, the cost for installation is estimated to be approximately $15,000. This would indicate a payback of 11.15 years.

AUTOMATICALLY CONTROL PROCESS HEAT

In order for heat producing equipment to be at the proper temperature when a shift begins, steam must be left on during off-shift hours. This results in approximately 128 hours per week of steam use when it is not required. The following table shows the pounds of steam per hour and per week consumed during non-use hours.

	Hour	Week
Preheat Oven, 1-05-2, CHAPARRAL, STINGER	30	3,840
Hot Water Probe, 1-05-2, CHAPARRAL	50	6,400
Melt Kettle, 1-05-2, HAWK, CHAPARRAL, STINGER, DRAGON	50	6,400
Melt Kettle, 2-05-2, COPPERHEAD	50	6,400
Grid Melt Unit, 3A-05-1, M549A1	35	4,480
Dopp Kettle, 3A-05-1, M549A1	25	3,200

By utilizing a timer/controller to heat the equipment to the proper temperature by the beginning of a shift, substantial energy could be saved. The following table shows the potential savings in pounds of steam per week and per year (assuming 85% of the non-shift steam could be saved and 50 weeks per year of production).

	Week	Year
CHAPARRAL	14,144	707,200
STINGER	8,704	435,200
HAWK	5,440	272,000
DRAGON	5,400	272,000
COPPERHEAD	5,440	272,000
M549A1	6,528	326,400

Using $6.00 per thousand pounds of steam, the following savings could be realized per year:

	Savings (Dollars)	Savings (MBTU)*
CHAPARRAL	4,243	818
STINGER	2,611	503
HAWK	1,632	315
DRAGON	1,632	315
COPPERHEAD	1,632	315
M549A1	1,958	377

*5 psig steam at 1156.3 BTU/lb.

The acquisition and installation cost of a timer/controller would be approximately $5,000. Payback would vary from 1.2 years to 3.1 years, depending upon the item in production.

Automatic timer/controllers have been installed on equipment at Buildings 1-63-4 and 1-63-5 (M718/M741 Main Charge Pressing Area) and at Building 1-10 (I-TOW Presses).

The following table shows the steam consumed during non-use hours (i.e., before installation of timer/controllers) for both 1-63-4 and 1-63-5:

Pounds/Hour	Pounds/Week	Pounds/Year
208.74	26,718.72	1,335,936

(Basis: 128 non-use hours per week; 50 weeks of production per year.)

The following table shows the savings resulting from the installation of automatic timer/controllers at Buildings 1-63-4 and 1-63-5, based on a steam cost of $6.00 per 1,000 pounds and a latent heat of vaporization equal to 945.71 BTU/LB for 15 PSIG steam:

Pounds/Year	Dollars Per Year	MBTU/Year
1,231,566	7,389.40	1,164.70

The following table shows the steam consumed by the I-TOW pressing operation at Building 1-10 during non-use hours prior to the installation of automatic timer/controllers:

Pounds/Hour	Pounds/Week	Pounds/Year
161.47	20,668.16	1,033,408

(Basis: 128 nonuse hours per week; 50 weeks of production per year.)

The following table shows the savings resulting from the installation of timer/controllers, based on a steam cost of $6.00 per 1,000 pounds and a latent heat of vaporization equal to 903.91 BTU/LB for 60 PSIG steam:

Pounds/Year	Dollars Per Year	MBTU/Year
871,938	5,231.63	788.15

RECLAIM HEAT FROM HIGH PRESSURE STEAM TRAPS

An engineering study was made during the Line 3 phase of this project. It is repeated here with revised costs to emphasize the potential of this project.

Each L/A/P production line has two melt buildings which utilize 150 psig steam to heat water for building heat. The average melt building requires 5,776 MBTU per year for heating. An average heating season is 5,088 hours.

$$\text{Average} - \frac{5776 \text{ MBTU}}{5088 \text{ Hours}} = 1,135,220 \frac{\text{BTU}}{\text{Hr}}$$

$$\frac{1,135,220 \text{ BTU/Hr}}{857.2 \text{ BTU/Lb}} = 1,324 \frac{\text{Lb}}{\text{Hr}}$$

$$\frac{1324 \text{ Lb/Hr}}{.80} = 1650 \frac{\text{Lb}}{\text{Hr}}$$

$$h_{fg} = 857.2 \text{ BTU/Lb}$$

Efficiency = 80%

Condensate from 150 psig steam has a heat content of 339 BTU/Lb. Since the condensate is presently not utilized, the maximum potential for savings would be:

$$1650 \frac{\text{Lb}}{\text{Hr}} \times 339 \frac{\text{BTU}}{\text{Lb}} = 559,350 \frac{\text{BTU}}{\text{Hr}}$$

$$559,350 \frac{\text{BTU}}{\text{Hr}} \times \frac{5088 \text{ Hr}}{\text{Year}} = \frac{2,846 \text{ MBTU}}{\text{Year}}$$

Process steam (5 psig) could be supplemented by using a flash tank and also a heat exchanger to recover the heat from the remaining condensate. A 150 psig-to-5 psig flash tank has the capability to flash 14% of the hot condensate to 5 psig steam.

$$1650 \frac{\text{Lb}}{\text{Hr}} \times .14 = 231 \frac{\text{Lb}}{\text{Hr}}$$

$$231 \frac{\text{Lb}}{\text{Hr}} \times 1156.4 = 267,128 \frac{\text{BTU}}{\text{Hr}}$$

The remaining condensate could be utilized in a heat exchanger to preheat incoming air or process water. The maximum heat available would be:

$$559{,}350 \frac{BTU}{Hr} - 267{,}128 \frac{BTU}{Hr} = 292{,}222 \frac{BTU}{Hr}$$

A conservative estimate of the savings of this remaining heat would be 30 - 50,000 BTU/hr. Therefore, total savings would total approximately 300,000 BTU/hr or 1,526 MBTU/Yr (flash steam plus hot condensate recovery). Using August 1982 steam costs of $5.00 per MBTU, a savings of $7,630 per year could be realized.

Costs involved in installing the flash tank, heat exchanger and all necessary piping would be approximately $5,000. Therefore, this project could self-amortize in one heating season. Assuming 2,000 hours per year of actual production time, this would equate to 534 MBTU per year of direct process energy savings. The remainder of the savings would be realized in building heat savings.

INSULATE PRESSES

Introduction Note:

It is understood that a project to develop a method of pressing the I-TOW and M718/M741 charges at room temperature (i.e., with unheated presses) is currently in the preliminary stages. Significant savings would result if this method of pressing could be perfected, as the process steam required to heat the presses would be eliminated and the air conditioning load would be greatly reduced (possibly eliminated at I-TOW press bays). It is therefore recommended that every effort be made to successfully complete this project; however, if it is found that it is not possible for the pressing operations to be carried out at room temperature, it is recommended that a project to find a feasible method of insulating the presses be undertaken.

As noted in our initial report, the main problems encountered in attempting to insulate process equipment such as melt kettles are irregularity of surface shape and "wash down", the cleaning of equipment by spraying with steam/hot water. In trying to insulate the presses, the latter is not applicable as presses are not "washed down" but are "vacuumed" with a contaminated vacuum system for clean-up. Irregularity of surface shape is still a factor, although not as severe as with a melt kettle. Any insulation applied to the press would have to have a smooth outer surface or cover that would prevent damage and pieces of insulation from flaking or breaking off, and also prevent the absorption or collection of explosives.

The advantages gained by insulating the presses are reduction of process heat requirement, reduction of cooling load, and improved work environment.

The heat loss for one I-TOW press is approximately 10,000 BTUH. Assuming a 1.5 inch layer of calcium silicate or equivalent insulation could be applied, the heat loss with insulation is estimated to be around 2,000 BTUH per press, for a savings of 8,000 BTUH per press. Assuming 2,000 hours of production per year, this comes to a saving of 16 MBTU per year for each I-TOW press.

Costs for installing the insulation were estimated to be around $200 per press, resulting in an amortization period of about two years.

CONCLUSIONS

1. Energy consumption baselines were established for eight production items: the Hawk, Stinger, Chaparral, Dragon, Copperhead and Improved TOW Warheads, the M549Al RA Projectile and the M718/M741 AT Projectile.

2. A number of potential energy saving measures amounting to 7,455 MBTU per year were defined and evaluated for present production rates.

RECOMMENDATIONS

1. Consideration should be given to implementation of the energy saving measures proposed.

2. Investigate presently available hardware and/or develop in-house a device to install on exhaust fan controls to shut off exhaust fan when it is not required. A device of this nature could be installed on items such as paint booths, acetone and other fume removal hoods, inspection table hoods, etc.

One possibility would be a pneumatic switch and pressure-electric relay automatically actuated by the operator standing on a contact plate. When the operator moves off the plate for an extended period of time, the fan would be shut down. A timer should be incorporated so that the fan would not be shut off every time the operator steps off the plate for only a few seconds, to pick up supplies, for example. The potential exists for a significant amount of savings to be realized by the installation of this type of device due to the large number of fume removal systems, paint booths, and similar equipment employed in production areas. The savings would result from decreased electrical consumption and decreased heating (or cooling) load.

Any device to be installed would, of course, have to be approved by the Safety Department for installation in hazardous areas.

3. On all new and replacement equipment, purchased for installation, it is suggested that all electric motors be specified to be of the new "Energy Efficient" type. Such motors generally return substantial savings in energy charges and additional savings from reduced maintenance costs, compared to conventional, less efficient motors. As an adjunct, synchronous drives (rather than conventional V-belt drives) should be considered for installation with energy efficient motors. A recent magazine article indicated synchronous drives can be 5 to 6 percent more efficient than V-belt drives of proper design. It also asks why one would spend the additional money for an energy efficient motor and then "throw the savings away with an inefficient (V-belt) drive."

4. Certain process equipment such as hydraulic units, vacuum pumps, etc., are presently water cooled. While the existing equipment is installed in locations which would preclude the possibility of a changeover, it is recommended that, if this equipment should ever be relocated or if similar equipment is purchased for new installations, air cooling rather than water cooling be considered. Possible savings from reduced operating and maintenance costs would result.

It is felt that in the future water will come to be considered in a manner similar to steam, electricity, and compressed air for conservation purposes. In certain areas, water conservation is important now. In this event, a change from water to air cooled equipment would also be a conservation technique of great value.

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